

NAVAL POSTGRADUATE SCHOOL

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THESIS

WEB-BASED TEACHING AND LEARNING OF ELECTRICAL ENGINEERING COURSES

by

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March 2001

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**WEB-BASED TEACHING AND LEARNING OF
ELECTRICAL ENGINEERING COURSES**

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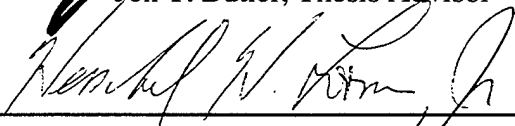


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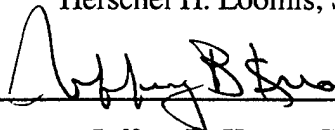
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ABSTRACT

This thesis describes the design of an interactive Web-based course, namely EC4810 Fault Tolerant Computing, taught in the Department of Electrical and Computer Engineering (ECE), at the Naval Postgraduate School. It is part of the ECE Department's Distributed Learning program in which students will use multimedia enhanced online courses through the Web. A major accomplishment of this thesis is the development of a template for other courses. A step-by-step guide has been developed that outlines the process of online course maintenance and procedures for producing other courses.

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EXECUTIVE SUMMARY

Applying the Web to educational purposes is a major field of research today. Advances in the World Wide Web and the availability of powerful personal computers for the home and the school, have enabled new Web-based techniques for teaching. This thesis describes the design of an interactive Web-based course, namely the EC4810 Fault Tolerant Computing, taught in the Department of Electrical and Computer Engineering (ECE), at the Naval Postgraduate School. It is part of the ECE Department's Distributed Learning program in which students will use multimedia enhanced online courses through the Web.

A recent survey by Macromedia Inc. indicates that 93% of major corporations are considering online learning. Today, the Web-based teaching (WBT) market is \$3 billion. With a market growth rate of 40%, the WBT market is projected to be \$5.5 billion by 2002. Another independent study by OmniTech Corporation shows that WBT share of the instructional market has grown from 5% in 1997 to 22% in 2000, while the traditional classroom method has decreased from 78% to 50% in three years. From a cost standpoint, Merrill Lynch concluded that, "What used to cost \$300 for an hour of instruction using the classroom, will be \$0.03 in 2005 using WBT, four orders of magnitude difference!" It is reasonable therefore to conclude that WBT is the right direction for the NPS to work towards.

Although rapid advancements in Web authoring software have created the possibility of delivering online learning to a wider audience, tapping this potential and selecting the right tools for use is not always easy. Hence, this thesis sought to identify

which are the recent Web technologies available and investigate which is the most suitable for the production of WBT ECE courses. Based on prior research work accomplished in the same field, and upon further investigation, it was concluded that COTS authoring tools are the most suitable for WBT ECE course production. In addition, the COTS authoring tools of choice selected for this thesis work are Macromedia's Authorware 5.2 and Microsoft's FrontPage 2000.

Subsequently, the actual process of designing, developing and delivering the course on the Web can be a more difficult task. The goal was to design and develop a prototype online course for EC4810. At the initial phase, the author had to learn and be proficient in the use of the selected COTS authoring tools. Thereafter, proper analysis and careful planning were needed to ensure that all critical requirements were understood and met. The design and development phase were the most task intensive. A major accomplishment of this thesis is the development of a template for other courses. Eventually, a step-by-step guide was developed that outlines the process of online course maintenance and procedures for producing other courses. It was shown that using the developed template and step-by-step guide can help reduce development time by as much as 50%.

Finally, as Web technologies are evolving so rapidly, it is imperative that we keep pace with the changing techniques and maintain the online course up to date. This thesis continues to investigate what are some enhancements possible for incorporation into future online courses. In particular, audio and video capabilities were investigated and discussed. It was clear that multimedia rich applications using audio and video techniques

required much more storage space and hence greater bandwidth on the Internet. Traditional Web technology was not designed to handle these applications well. Because of the greater interactivity these applications can bring, and a corresponding increased demand, new compression and streaming technologies were developed to overcome the Web limitations. It was concluded that audio and video technologies can indeed enhance one's WBT experience and it is recommended that further research be done in this area.

In summary, the undertaking of this thesis project has provided the author with many learning opportunities of the World Wide Web and its associated technologies. In particular, Web-based teaching and learning of ECE courses were investigated. The results were the design and development of a WBT online course and Web page for the EC4810 Fault Tolerant Computing course. A step-by-step guide for creating new courses and for future maintenance was formulated in the process. These products need to be continuously updated to keep pace with new information and evolving Web technologies. One area of consideration was the incorporation of audio and video in WBT courses.

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I. INTRODUCTION

A. AREA OF RESEARCH

Applying the Web to educational purposes is a major field of research today. The availability of affordable and powerful personal computers for the home and the greater availability of high-powered communications technology in the school have enabled new Web-based techniques. It has allowed a paradigm shift from the traditional classroom experience.

Although the idea of applying computers for educational purposes has existed for 30 years, relatively inexpensive computing and the Internet have made this practical nowadays. The Web has created an educational environment in which lecturers and students can communicate with each other anytime and anywhere. It extends educational opportunities from university campuses to virtually anywhere in the world.

Recently, the Naval Postgraduate School (NPS) has provided high quality Video-TeleEducation (VTE) to off-campus students. Today, NPS aims to be the leader in Distributed Learning graduate education for the Naval Forces and other Department of Defense organizations, by merging the existing tele-video technology with Web-based learning, to provide a comprehensive and widely accessible, continuous learning to the Fleet.

In line with this vision, the Department of Electrical and Computer Engineering (ECE) at NPS has initiated a Distributed Learning program targeted at extending the benefits of a militarily-relevant electrical and computer engineering education to more

people, by providing a wide selection of multimedia enhanced online courses through the Web.

The goal of this thesis is to develop an interactive Web-based course, namely EC4810 – Fault Tolerant Computing, taught in the ECE Department. It includes self-paced lectures, quizzes, tutorials, research projects, sample examination papers, and grading criteria. The online course developed for this thesis was designed using commercial-off-the-shelf (COTS) software, and builds upon significant prior research done by Wilson Low in his thesis project “Investigation and application of recent Web-based technologies to the teaching of electrical engineering courses” [Ref. 1].

Lessons learned through previous work in this area were incorporated as much as possible, while every attempt was made to verify and update information used. A major accomplishment of this thesis was the creation of a simple step-by-step guide outlining the maintenance of the online course for future updates. It describes procedures to use this course as a template for developing other courses.

B. RESEARCH QUESTIONS

The rapid advancements in Web authoring software have created the possibility of delivering online learning to a wider audience. However, tapping this potential and selecting the right tools for use is not always easy. Subsequently, the actual process of designing, developing and delivering the course on the Web can be a more difficult task. As Web technologies are evolving so rapidly, it is imperative that we keep pace with the changing techniques and maintain the online course up to date. This thesis sought to

investigate and address these three issues as summarized in three research questions.

They are as follows:

- Which recent Web technology is the most suitable for the production of Web-Based Training (WBT) ECE courses?
- To what extent are guides suitable for the creation and maintenance of online courses?
- Are new features such as sounds and movies relevant and matured enough for incorporation in WBT courses?

C. ORGANIZATION OF THE THESIS

Chapter I outlines the area of research for this thesis and presents the overall organization of this report.

Chapter II reviews significant prior research done in this topic on Web-based teaching and learning of electrical engineering courses. It discusses the benefits of Distributed Learning and evaluates the recent technology available for WBT productions. A template for developing WBT courses was selected for this thesis.

Chapter III explains the step-by-step design and development process of producing the EC4810 Homepage and the online course. A result of the production was a manual for future maintenance and development of new courses.

Chapter IV looks at new features available for WBT production and evaluates the feasibility of incorporating them. This lays the groundwork for future work in the direction of WBT.

Chapter V contains the conclusions and recommendations.

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II. SIGNIFICANT PRIOR RESEARCH

A. WHY USE WEB-BASED MULTIMEDIA DISTRIBUTED LEARNING?

Distributed (or distance) learning is a type of education where students complete courses and programs at home or work, communicating with faculty and other students via e-mail, electronic forums and videoconferences. Learning experiences are no longer limited to traditional classrooms. Today, many Web-Based Training (WBT) courses are being produced for distributed learning through the Web, and most are developed with extensive multimedia enhanced technology.

Multimedia technology employs computer-controlled integration of text, graphics, sounds and animation to create a dynamic audio-visual presentation that can significantly capture a user's attention and interest. This has proved to be a very effective tool for education and can greatly improve a student's learning experience, while reducing the time needed to comprehend the course materials.

Multimedia technology can also be used to build interactivity, an element crucial to the success of any educational system. We know that human learning is enhanced through direct involvement. Hence, courses built with multimedia tools that employ significant interactivity can help users to actively participate in processing the course materials, thereby improving the level of understanding and increasing the amount of knowledge retained. Research has shown that interactive applications can improve proficiency by up to 40 percent over conventional training, while cutting instruction time by half [Ref. 2].

The advent of the World Wide Web (WWW) has caused a major change in education today. Web-based educational systems are asynchronous, that is, they do not require simultaneous presence of teacher and students. The Web enables worldwide access independent of time and location. Using such system does not require expensive equipment; a personal computer, nearly any operating system, a Web browser, a modem, and a telephone connection to an internet service provider enable entrance to the Web and thus to Web-based educational systems. Indeed, users can now easily access Web-based learning using computers connected to the Internet anywhere, anytime, and more importantly, to work at their own individual pace. The same is true for instructors who can build and maintain Web-based courses anywhere, anytime.

The use of computers to deliver learning in an organization is not new. However, the easily available access to the Web is accelerating the adoption of Web-based multimedia distributed learning. A recent survey indicates that 93% of major corporations are considering online learning. Today, the Web-based training market is \$3 billion and growing at a rate of 95% per year [Ref. 2].

B. RECENT TECHNOLOGIES FOR WBT COURSE PRODUCTION

The goal of this section is to identify several recent technologies available for use to develop WBT courses, and to evaluate which is the most appropriate for WBT course production. Significant prior research [Ref. 1] has been done in this area and whenever relevant, results will only be cited to avoid duplication. It was shown that the preferred

criteria to use for evaluating a suitable technology for WBT course production is as follows:

- Uses commercial-off-the-shelf (COTS) software
- Has short development time
- Encourages interactivity
- Has good maintenance/upgrade support
- Is cost effective

Several recent technologies used to develop WBT courses were also previously identified [Ref. 1]. A summary of each will be discussed in this section, and they include the following:

- Lecture materials published on web pages
- Microsoft PowerPoint slide shows that run on the web browser
- An interactive course developed using a high level language
- An interactive course developed using a proprietary software package
- An interactive course developed using COTS authoring tools

1. Lecture materials published on web pages

Preparing electronic versions of lecture notes and books is a fast and easy way to go online on the Web. There is little need for significant programming knowledge, or knowledge of Hypertext Markup Language (HTML) or Java. Software tools allow one to export from nearly every word processing program into HTML.

Although it is the easiest, this approach is the worst and most inefficient with respect to educational success. Merely presenting an electronic version of lecture materials on the Web makes little use of multimedia animation and interactivity. Pure online books are useful, but are limited to technical reports/journals, online manuals, or software documentation.

2. Microsoft PowerPoint slide shows that run on web browsers

Traditionally, instructors have used Microsoft PowerPoint to generate slides for classroom lectures. These slides can be printed out as handouts or printed on transparencies for overhead projection. In recent times, most classrooms have been installed with video projectors linked to a computer, where the PowerPoint slides can be activated as a slide show. Indeed, most instructors are familiar with this, and it is commonly used.

With the advanced of Local Area Network (LAN) on most campuses, computers in classrooms are all connected together. Instructors can now log in through the LAN in class to access files from their own account. Internet technology has brought this technique a step further, extending beyond the campus. With minimum technique, PowerPoint slides can be easily incorporated into a website. This way, an instructor can access his/her slides beyond a campus LAN. Many have exploited this capability and built up personal websites to offer WBT course.

However, there are inherent disadvantages with this technique. PowerPoint slides are generally large in size and not optimized for the usual Web page display. Slide shows produced this way have limited animation and do not allow any real-time feedback.

3. WBT course developed using a high level language

High-level languages such as Java, Visual Basic, C++, etc., can be used to develop WBT courses from scratch. This has the advantage of high flexibility and allows full customization to meet most requirements of an effective WBT course.

However, there are two main disadvantages that make this a rarely chosen option. The first is its high development cost. The other is poor maintainability of program codes. Instead, there are many application-specific software tools available to help developers build WBT courses. These software packages allow visual and icon-based design to self-generate the necessary low level language, relieving developers from having to learn the underlying program codes. The two main categories of this type of software package tools are discussed in the next two sections.

4. WBT course developed using a proprietary software package

Many proprietary software tools tailored for WBT course production have since been introduced in the market. In an attempt to be among the first to introduce WBT courses, many organizations have embraced these products due to the ease of use and relatively short learning curve involved. However, these packages tend to be expensive

(range of \$15,000 and above) and often lack the flexibility required to build electrical and computer engineering courses.

5. WBT course developed using COTS authoring tools

Midway between having to build from scratch using 1) a high level language and 2) a proprietary software package tailored specifically for WBT course production, are the COTS interactive software tools. Some of the more common COTS tools include Macromedia Authorware 5.2 Attain, Macromedia Director 8, and Asymetrix Toolbook.

Two main advantages of COTS tools over proprietary software tools are its relatively lower cost (range of \$300 verses range of \$15,000) and higher flexibility. COTS tools also enjoy several other advantages over high-level language design, which include shorter learning curve, ease of use, good maintainability and better upgrade capability.

6. Recommended technology for use

Having discussed the various techniques available for WBT course production, a summary table is drawn up for comparison based on the preferred characteristics laid out earlier in this section as follows:

Methods to put online courses on the Web	Characteristics			
	Moderate development time?	Interactive?	Easily maintainable?	Cost effective?
Text-based materials as HTML (e.g. files with extension .txt, .doc, .rtf, .pdf)	Yes	No	Yes	Yes
PowerPoint slide shows	Yes	No	Yes	Yes
High-level language (e.g. Java, Visual Basic, C++, etc.)	No	Yes	No	Yes
Proprietary software package	Yes	Yes	No	No
COTS authoring tools	Yes	Yes	Yes	Yes

Table 1. Comparison of Methods to put online courses on the Web with desired characteristics

It can be observed from Table 1 above that using COTS authoring tools for developing WBT courses is the preferred choice of option.

C. SELECTION OF SOFTWARE TOOLS FOR WBT COURSE DEVELOPMENT

Two main software tools were used. The first was a COTS authoring tool required for packaging the lecture materials into an interactive online course. Macromedia Authorware 5.2 Attain was selected for this purpose. The second was a Website creation

and maintenance tool needed for packaging and launching the developed interactive course on the Internet. FrontPage 2000 was used.

1. COTS authoring tool – Authorware 5.2 Attain

Previous research [Ref. 1] has completed a thorough investigation and experimentation of various COTS authoring tools and narrowed to three main software tools, namely Authorware 5, Director 7 and Flash 3, all from Macromedia. In this research, further investigation was conducted. Although there are now other authoring tools available in the market, such as Toolbook from Asymetrix and Premiere from Adobe, the three main software tools from Macromedia remains the most popular and widely used. Within a year, however, all three tools have launched a new release, namely Authorware 5.2, Director 8 and Flash 5. A summary of the comparison of these three tools is presented in Table 2 below [Ref. 3].

	Authorware 5.2 (\$2800)	Director 8 (\$1000)	Flash 5 (\$400)
Overview	Authorware is the industry-leading tool for creating interactive, rich-media learning applications for delivery over the Web, LANs, CD-ROMs and DVD-ROMs.	Director is the standard for creating and delivering powerful multimedia for the Web, CD-ROMs and DVD-ROMs.	Flash is the standard for creating vector-based animations and graphics that are extremely beautiful, compact and resizable for the Web, CD-ROMs and DVD-ROMs.
Main use	<ul style="list-style-type: none"> • Computer-based training • Web-based training 	<ul style="list-style-type: none"> • Web-based multimedia • Demos, presentations 	<ul style="list-style-type: none"> • High impact branded sites • Web site interfaces • Narrative animations

	Authorware 5.2 (\$2800)	Director 8 (\$1000)	Flash 5 (\$400)
Primary Users	<ul style="list-style-type: none"> • Training developers • Instructional designers • Subject matter experts 	<ul style="list-style-type: none"> • Web developers • Multimedia professionals • Corporate presentation specialists 	<ul style="list-style-type: none"> • Web designers • Animators
User Interface	Icons on a flowline.	Frame-based using a powerful scripting language.	Timeline-based, graphical editing tools.

Table 2. Comparison of available WBT course development tools

Consistent with previous evaluations, Authorware 5.2 remains the author's choice for this thesis research. Authorware is a powerful and flexible tool optimized for developing all kinds of interactive multimedia. It was and remains the leading visual media-rich authoring tool for creating Web and online learning applications.

Some of the key advantages of Authorware are:

- Short learning curve – using icon drag and drop technique
- Highly interactive – many built in interactive features
- Ease of maintenance and upgrade – program flow in graphical form
- Flexibility in distribution – deliver in floppy disk, CD-ROM or the Internet
- Fast Web download – advanced compression and streaming technique

There are however two distinct weakness of Authorware. First, its built-in graphic editing function has limited capability. Secondly, the built in text editor lacked the

excellent text formatting, styling, coloring, spell check and auto-correct features of other software. Fortunately, most of the course materials were already available in PowerPoint slides format. As both Authorware and PowerPoint run on the same Microsoft Windows operating system, it was very convenient to cut and paste text or graphics from one application to another without much difficulty (details will be presented in the next chapter).

2. Website creation and management tool – Microsoft FrontPage 2000

Upon completion of the interactive WBT online course using Authorware, the next step was to launch it on the Internet with a EC4810 homepage. This homepage, more than hosting the WBT online course, should present other information about the course, such as the course description, objectives, outline, recommended reference textbooks, laboratory assignments, individual projects, sample examination papers and grading criteria. A website creation and management tool was required to help create, test, manage and maintain the EC4810 website. Two of the most popular tools were evaluated for this purpose, namely Microsoft FrontPage 2000 (\$70) and Macromedia Dreamweaver 4 (\$150).

FrontPage 2000 was the initial preferred choice, since it was installed in almost all the Windows NT computers on campus. It came bundled with the original Microsoft Office 2000 Premium Edition, and was designed with the same look and feel features as the other Microsoft Office products. Hence, it was relatively easy to use.

However, its lack of compatibility with most web servers is a serious weakness of the FrontPage 2000. Most of the interactive features such as forms, search, database, etc. created by FrontPage 2000 do not work on most Web servers, unless the proprietary FrontPage Server Extensions software from Microsoft are first installed [Ref. 8]. This proprietary software is not readily available, and the installation process is non-trivial. As such, most Web servers, including the NPS server that hosts the EC4810 Website do not have the necessary Server Extensions.

Nevertheless, due to the ease of use of FrontPage 2000, it was used for the initial design and creation of the EC4810 homepage.

Macromedia Dreamweaver 4, on the other hand, had more advanced features than the FrontPage 2000, and it was compatible with most Web servers without a need for Server Extension installation. It is, however, more expensive, and much more difficult to use. Because it was able to input all Web pages initially created by FrontPage 2000, Dreamweaver 4 can be used subsequently to add other advanced features to enhance the online course.

Having identified the two main tools most suitable for WBT course production, the next step was to use these tools to develop a prototype online course. Chapter III discusses the design and development of a prototype WBT course for EC4810 Fault Tolerant Computing.

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III. DESIGN AND DEVELOPMENT OF EC4810 COURSE

A. RESOURCES REQUIRED FOR SOFTWARE DEVELOPMENT

In order to produce a successful and effective WBT course, a team is needed. It was recognized that either the author fulfill all the member's functions or external assistance is needed. The various team members required are as follows:

1. Content Expert

The content expert is usually the instructor of the course material. For the purpose of this research, the author took the EC4810 Fault Tolerant Computing in the summer quarter of 2000 to be conversant with the course materials. Frequent consultation with the course professor occurred during the preparation of the online course.

2. Online Course Designer/Programmer

In designing the WBT course, the programmer is responsible for coding, testing, interfacing and integrating all the WBT components. The author took a three weeks directed self-study on how to use Authorware, completing all the lessons of the Macromedia Authorware Authorized 5 Attain training manual [Ref. 4].

3. Education Specialist

The education specialist is responsible for the effective organization and presentation of the WBT course materials online. The author had to surf the Web for sample online courses examples that were created using Authorware to learn from

experienced course developers [Ref. 5]. The previous EC2820 online course was also a rich example for learning and practice [Ref. 1].

4. Graphic Designer/Artist

The graphic designer is responsible for implementing visual rich graphics and animation to enhance the online course. Since the course materials were already available in PowerPoint slides built by a qualified graphic artist, the author's job was simplified by just importing the graphics into Authorware. However, much innovation and creative thinking was applied to incorporate animation into the online course.

5. Web Designer

To host the online course on the Internet, the Web designer's job was very similar to the graphic artist, with the additional requirement of knowledge in Web authoring tools and basic HTML programming. The author spent one week in familiarizing with FrontPage 2000 and created a personal Web page as a practice [Ref. 6].

6. Server Administrator

The server administrator is responsible for providing a Web site for publishing the developed WBT course, while ensuring protection from unauthorized access and modifications. For security reasons, the author had to consult the ECE online course server administrator for help.

B. EC4810 ONLINE COURSE PRODUCTION

The design and development process of the EC4810 WBT online course was similar to that used for conventional software development, as shown in Figure 1 below:

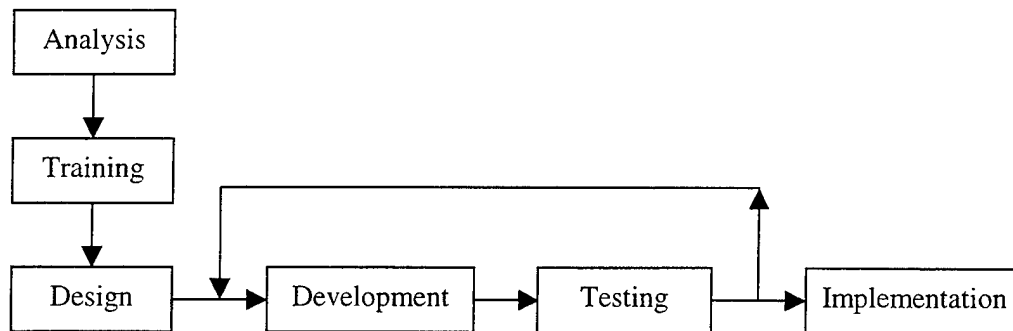


Figure 1. The Design And Development Process

Often, it was required that the development and testing phase be done incrementally and recursively, especially for a large project. It is so for this thesis work and both the EC4810 Online course and Homepage were developed and tested in incremental steps for easier management and control.

1. Analysis phase

A comprehensive discussion on the selection of a COTS authoring tool required for packaging the lecture materials into an interactive online course has been detailed in Chapter II. Macromedia Authorware 5.2 Attain was selected for its media-rich and highly flexible interactive capabilities. Prior research had produced an Authorware template that can be used for developing other electrical engineering courses [Ref. 1], and will be used in this research to verify its applicability and completeness.

2. Training phase

To start the Authorware application, select it from the Windows *Start | Programs | Macromedia Authorware 5 | Authorware 5* menu. The main working environment in Authorware is the *Design Window*. From there, elements of interactive media can be assembled onto a *Flowline*. Across the top of the window is the *Menu Bar*, and below it is the *Toolbar*. The *Icon Palette* that contains all the tools needed to build a project is along the left side of the Design Window, as shown in Figure 2 below:

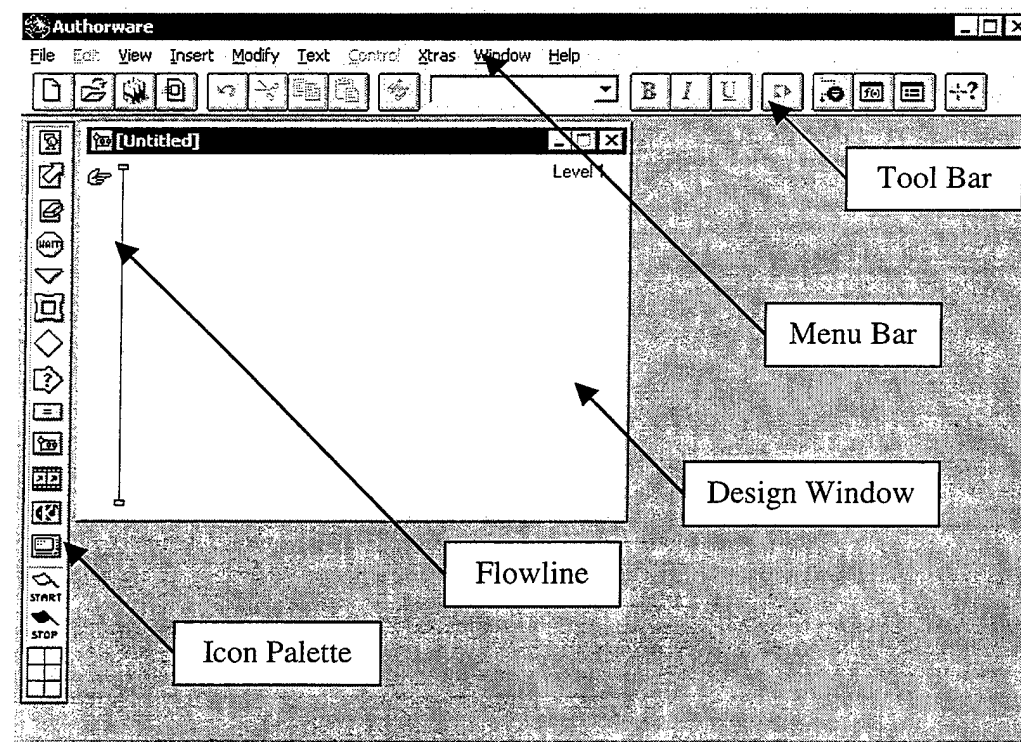


Figure 2. Main working environment of Authorware

To create an Authorware project, simply drag and drop icons from the icon palette to the flowline in the order that their contents are to be displayed. At places where the

flowline structure is horizontal rather than vertical downwards, the flow proceeds from left to right (see Figure 3 below). One can literally design the structure of a presentation just by placing icons along the flowline and then later add content to the icons. Each icon either contains media, such as text or graphics, or represents an action that is performed on one of the media elements. A list of tools available in the icon palette is presented in Appendix A.

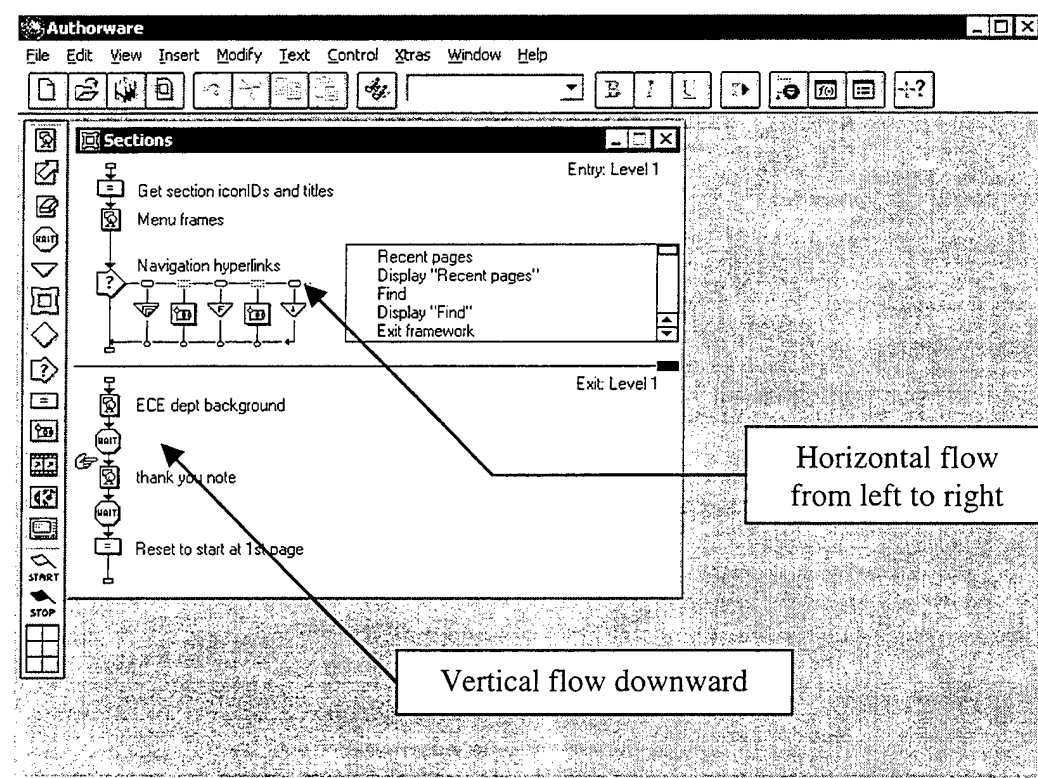


Figure 3. Horizontal and vertical flow of Authorware piece

Finally, to view or play an Authorware piece, simply click on the **Restart** button of the **Toolbar** menu and the **Presentation Window** will appear as illustrated in Figure 4. This presentation window shows how an Authorware piece will appear to the users when

executed externally from floppy disk or when launched from the Internet. This window also allows one to create text and simple graphics directly, while having the flexibility of manipulating all the visual elements in the project.

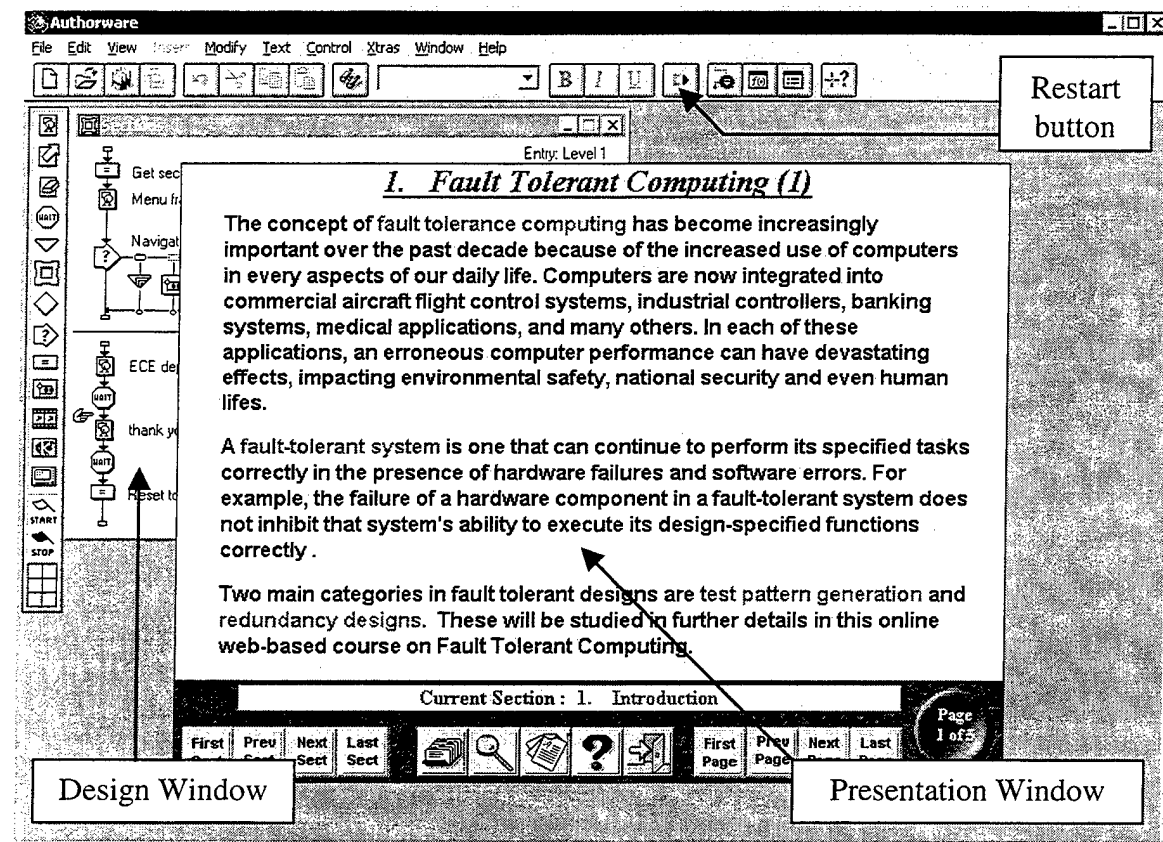


Figure 4. Presentation Window provides WYSIWYG design environment

Almost all the work is done using the Design Window (to assemble content) or the Presentation Window (to display content). With the drag and drop technique from the icon palette and the flowline concept, it was easy to use the Authorware software. The training phase spanned a total of three weeks, which included learning many other features such as Web packaging.

3. Design phase

Although learning the Authorware tool was relatively easy, there was no step-by-step documentation on how to use the template previously designed. Hence, part of the goal for this thesis was to understand and evaluate the template, and to produce a step-by-step manual documenting why and how to create and maintain future courses.

The general layout of the template was thought to be adequate with a screen area of 640 x 480 pixel to cater to all user screen sizes. This is especially crucial for viewing through a Web browser, which usually has a reduced screen space due to the browser toolbars as shown in Figure 5.

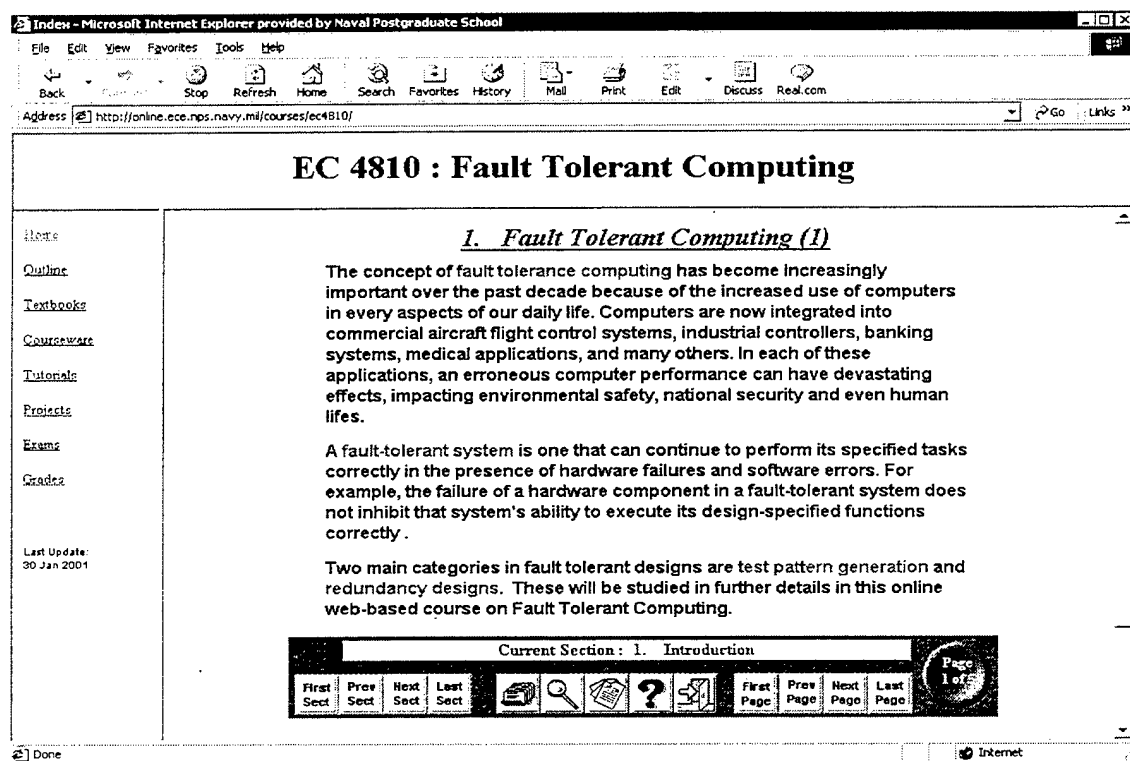


Figure 5. EC4810 Online Course through the Web browser

In designing for ease of navigation, the navigation buttons were neatly laid out at the bottom of each page and kept consistently throughout. These buttons were clearly labeled and graphically well designed with 3-D effects. A pull-down menu was automatically generated that will allow the user to scroll through the entire online course and branch to the exact page desired immediately as shown in Figure 6 below:

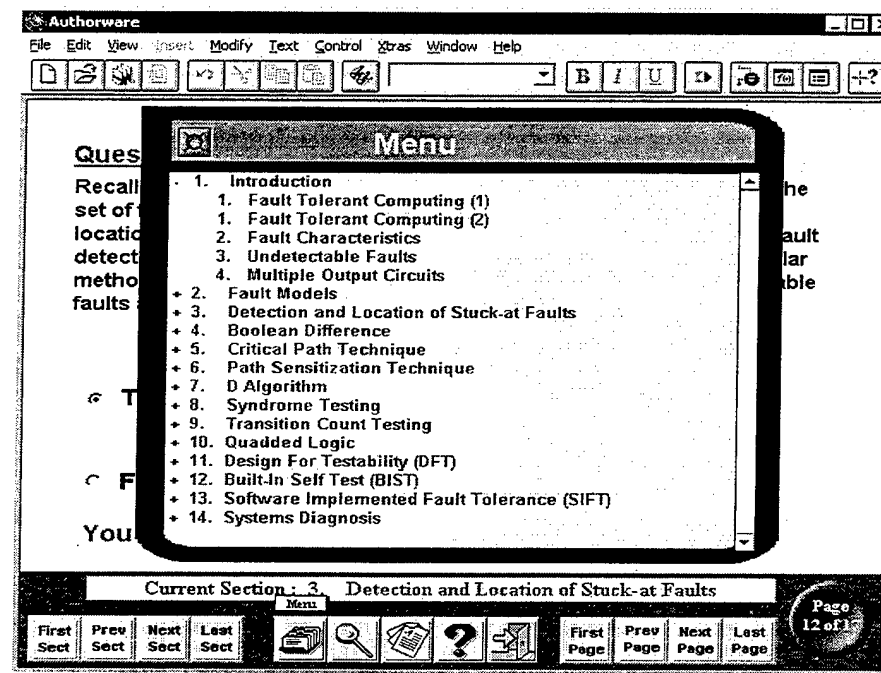


Figure 6. Automatically generated pull-down menu for quick reference or branch

4. Development phase

Following closely to the original lecture materials, the online course was organized into fourteen sections of between ten to thirty pages each. Quizzes were included at the end of each section to help the users review the section's material. A total of about three hundred pages of course materials and quizzes are delivered. Due to the

large size of the project, each section was developed incrementally and tested before additional materials were added. The Authorware icon and flowline concept was well suited for this kind of incremental design technique.

Significant level of interactivity was achieved by introducing simple true-false questions and various user-controlled animations. True-false questions are placed at the end of each section (as shown in Figure 7), where the user can participate by selecting one of two options and checking the answer by clicking on the *Check Answer* button. Alternately, the user can click on the *Check Answer* button direct for the correct solution without first selecting an option.

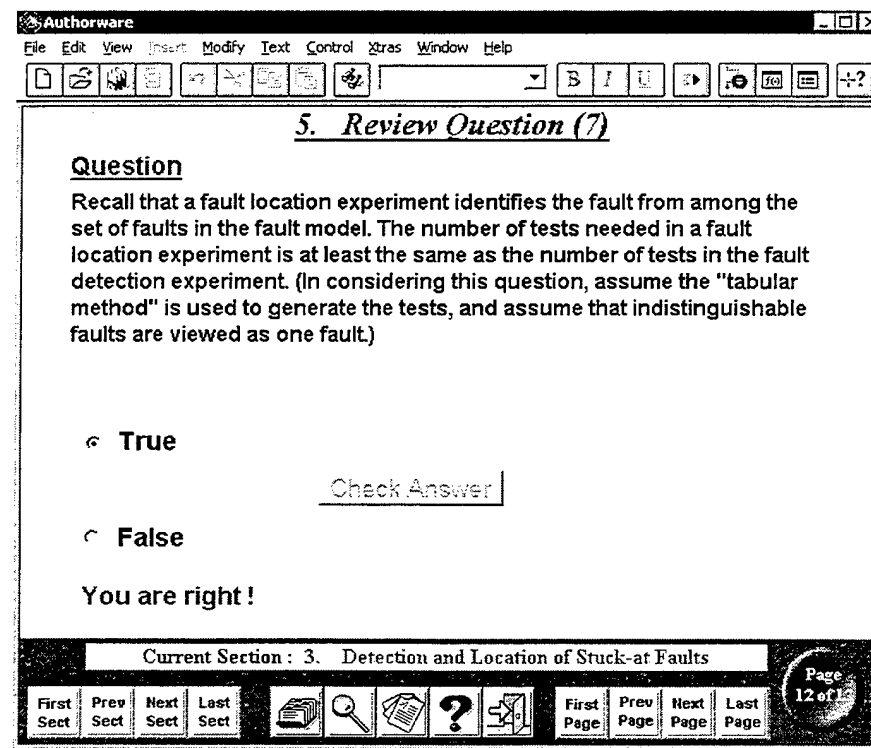


Figure 7. A true-false review question at the end of section three

As shown in Figure 8, animations were used to demonstrate how Static Hazards in combinational circuits can occur during intermittent transmission of signals caused by delays in gates. Animations are paused at regular interval to allow the user control over the pace of learning, through *Continue* buttons.

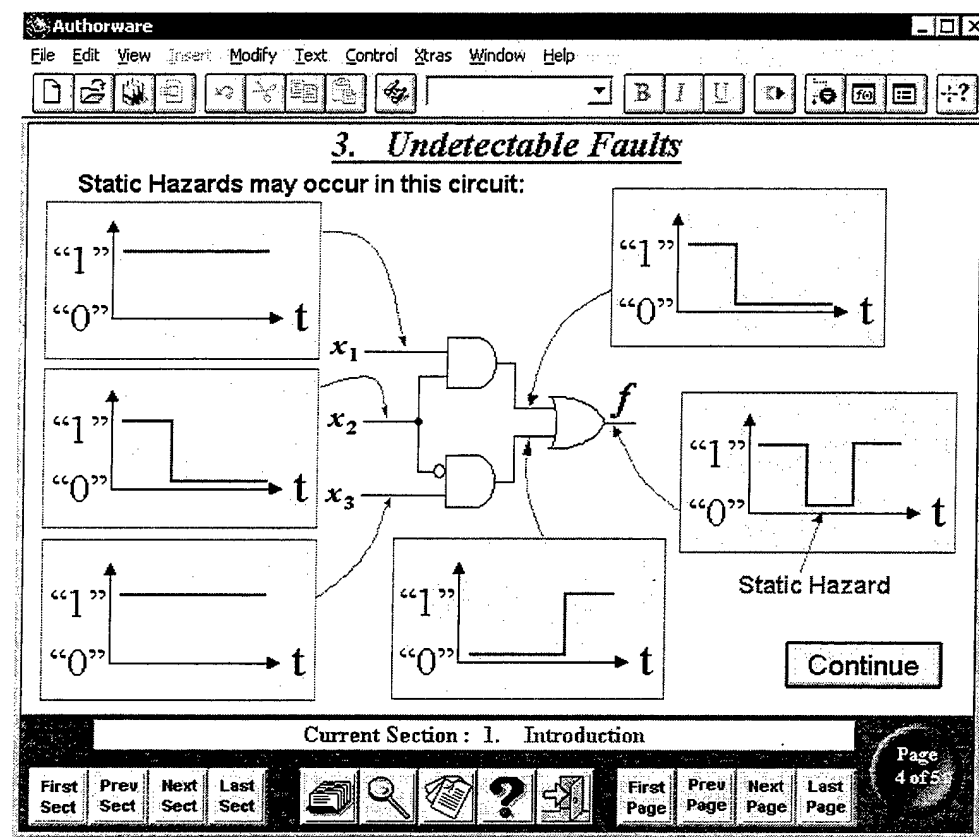


Figure 8. User-controlled animations of Static Hazards demo

The development phase was the most tasks intensive of all the phases, especially in the design of animation to illustrate complex processes and difficult concepts. Much effort was required to ensure consistency in terms of font types, colors and sizes used, as well as diagrams, images, and mathematical symbols employed. One major disadvantage

of Authorware was it did not have good word processing capabilities. Hence most spelling and grammar checks had to be done manually or through other external software before importing into the Authorware project.

5. Testing phase

The testing phase was done incrementally in tandem with the development phase. After every few pages were created, the *Presentation Window* was activated to check for layout and alignment consistency as well as any animation synchronization problems. Corrective actions were taken as appropriate. Subsequently, at the completion of every section, further testing was accomplished. After the first two sections were fully developed, the whole project was compiled into a format ready for publishing. It was then checked for correctness by executing from the hard disk and also launching from a Web browser. Because a total compilation and publishing test phase was very time consuming, this form of testing was done only after several sections have been completed and prior to the final implementation phase.

6. Implementation phase

Upon completion of all the fourteen sections, detailed testing were conducted to ensure consistency and that navigation between sections and pages had no problem. The keyword search and list of recently accessed pages were also tested. A final compilation was performed and the resultant executable file activated to check for correctness and

completeness. A Web-publishable version was also obtained and downloaded to the NPS Web server for testing. Details are documented in Appendix A.

C. EC4810 WEB PAGES PRODUCTION

As presented in Chapter II, Microsoft FrontPage 2000 was the Web site creation and management tool used. Macromedia Dreamweaver 4.0 can be used for evaluation as a possible future development tool.

1. Analysis phase

Drawing on lessons learnt from previous related studies, the objectives and requirements of creating the EC4810 Homepage were analyzed and understood. The main objective of the homepage was to provide a Uniform Resource Locator (URL) for launching the EC4810 online course, while providing vital links and information about the course in general. The requirements are three fold; first, it must be easy to navigate, second, the layout of every page must be well organized and consistent, and third, all information presented must be accurate and up to date.

With the objectives and requirements clearly understood, the author set out to obtain the necessary tools and training for development work.

2. Training phase

Because FrontPage 2000 was readily available on campus, the author did not have to go through the installation process. However, there are many commercially available books that provide detailed instructions on how to install the FrontPage related components of the Microsoft Office 2000 Premium Edition [Ref. 7] if required. Launching the application was a simple one-step procedure of selecting it from the Windows *Start | Programs | Microsoft FrontPage* menu. Details of how to start using FrontPage 2000 are included in Appendix B. To begin a one-week self-study of the FrontPage 2000 tool, two books [Ref. 7 and 8] were of significant aid as a reference guide.

It was discovered that the design and development of a Web page could be done on a local hard disk during the initial stages, without the need of a Web server or Internet Service Provider (ISP). FrontPage 2000 allows one to launch a Web browser of choice to view the design.

One of the main advantages of FrontPage 2000 is its ease of use, offering six different views a designer can use when creating or managing a web page. The most common of which is the Page view, which allows user to enter and edit text, while providing a What-You-See-Is-What-You-Get (WYSIWYG) environment. This view also allows easy addition of pictures, frames, tables, forms, sound, video, hyperlinks, hotspots and active FrontPage components to the web page. Drag and drop capability like other Microsoft Office products were of significant help in making the training phase an enjoyable experience.

3. Design phase

The first step to a successful Web design was to be done on pen and paper, away from the computer [Ref. 9 and 10]. Organizing the contents and deciding the use of space, color, font type, and graphics were of crucial importance.

It was decided that a tree structure shown in Figure 9, with a total of eleven different pages were adequate for designing the Website.

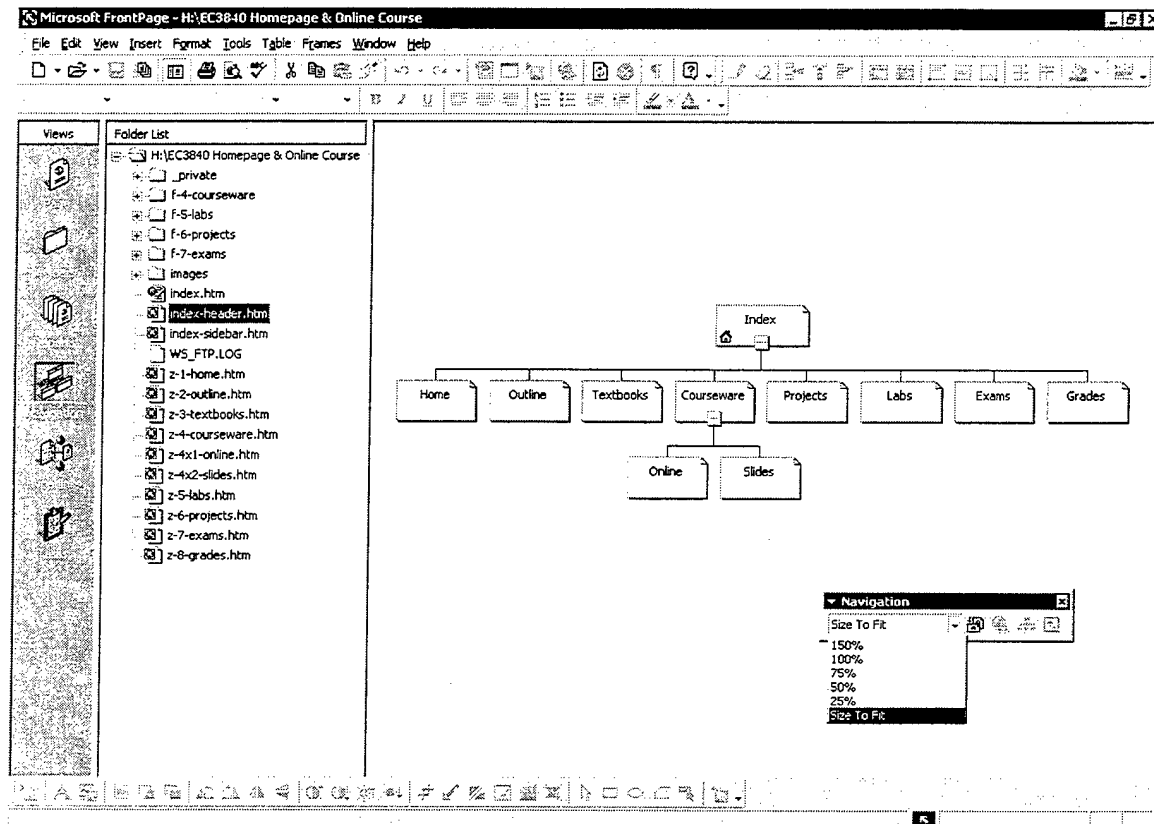


Figure 9. Map structure of EC4810 Web site in Navigation view

The layout was designed to be consistent for all the pages, with intuitive navigation menus presented at the top and left side bar of each page. Background and graphics can be obtained from the rich resources found on the Internet. To extract an

image of interest, simply right click on the mouse and select the 'Save Background As' or 'Save Picture As' option. Rename the image as necessary and place it in the images folder for later use. In the FrontPage 2000 Page view, simply drag and drop the image onto the desired page. See Figure 10 for a sample single page layout.

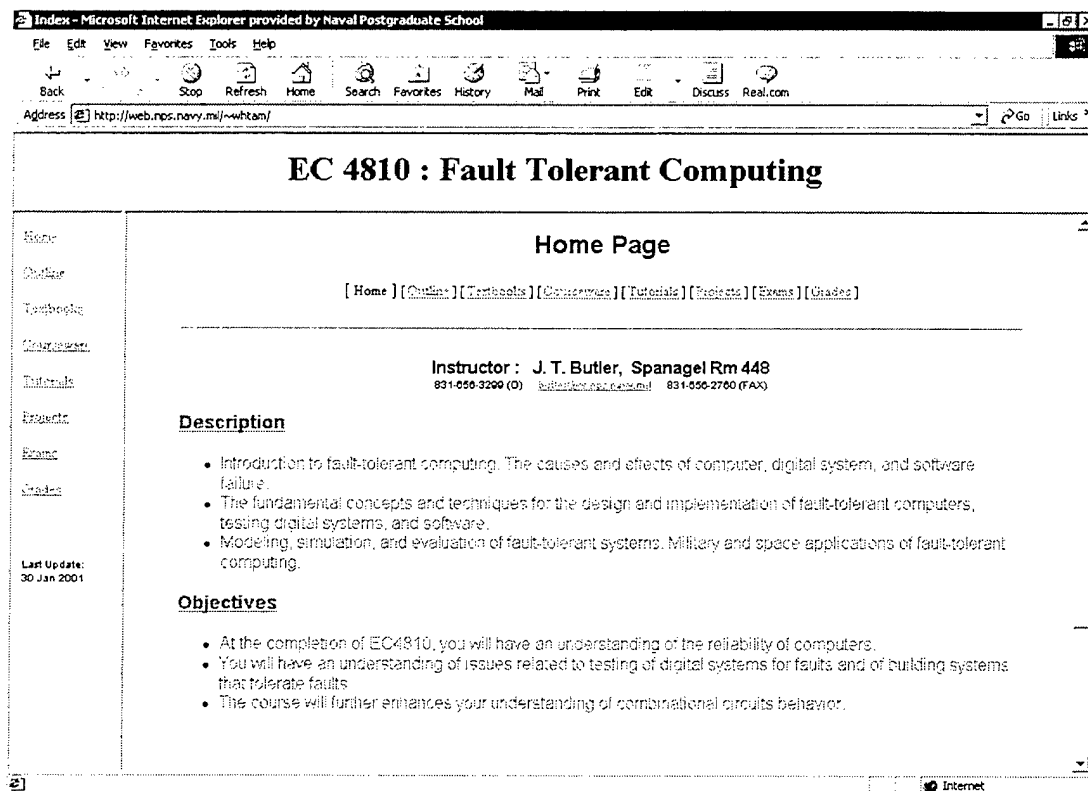


Figure 10. Final layout design of EC4810 Homepage

Font types, sizes and colors used were standardized for all the different pages to create a uniform and professional look. Links to relevant sites such as recommended textbooks, instructor, creator of homepage, NPS, disclaimer and the Authorware plug-in were also included.

4. Development phase

The development phase follows after the design of the main homepage. Although this phase is the most task-intensive, putting together the rest of the pages with relevant information were relatively easy if the previous design phase was well planned and documented.

Incorporating the online course developed using Authorware proved to be difficult, since all file names referenced must be case sensitive, otherwise it will not work. The details are documented in Appendix B.

5. Testing phase

The testing phase should be done incrementally with the development phase, as the various pages are being created. While in the Page view with the page of interest highlighted (i.e. double click on the html file name), select the **File | Preview in Browser** option. A window like that of Figure 11 will be displayed.

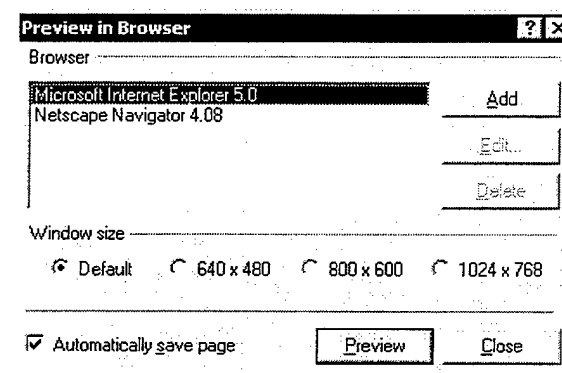


Figure 11. Preview in Browser window

Select the *Automatically save page* option before clicking on the *Preview* button for a new Web browser Window to open, showing exactly how the designed web page will look when launched through the Internet. It is recommended that both the Microsoft Internet Explorer and Netscape Navigator be tested to ensure that all features in the web page are presented as expected.

6. Implementation phase

Finally, to publish the completed work of both the EC4810 online course and homepage on the Internet, a Web server needs to be identified. Two different sites were experimented with; namely the NPS Web server [Ref. 12] and the ECE Web server [Ref. 13]. The File Transfer Protocol (FTP) can be used to copy all the files containing the web pages and graphics to the Web server. Figure 12 shows the screen for this.

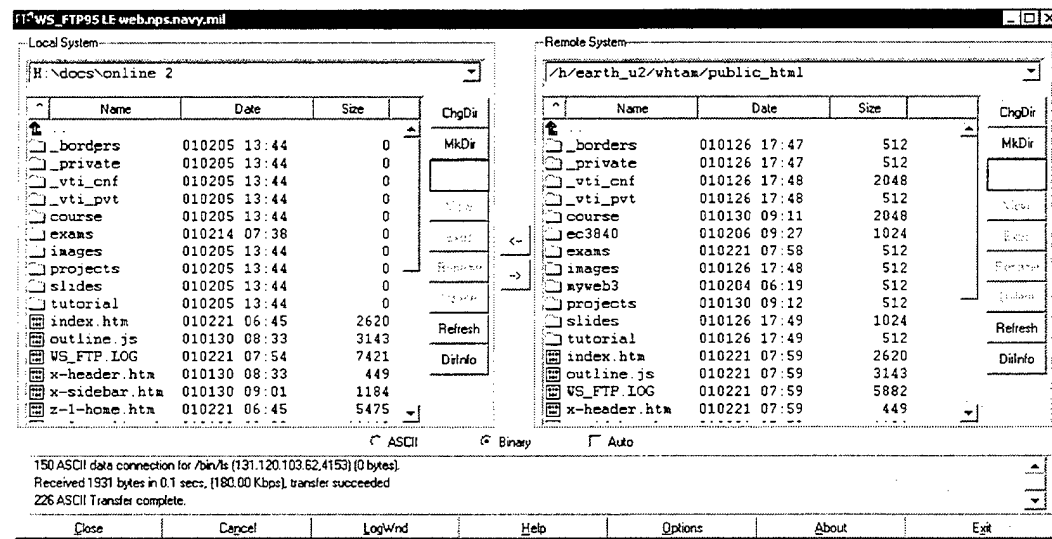


Figure 12. FTP software to transfer files

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IV. NEW FEATURES FOR IMPROVED WBT COURSE

Online learning applications are essentially a collection of media elements that have been organized and logically presented to provide an effective learning experience for the user. There are five major types of media elements [Ref. 4] as shown in Table 3 below.

Types of Media elements	File assumptions	Typical file size (kilobytes)
Text	ASCII text file containing 270 words	2
Animation	Animation in Flash	108
Graphics	Four 320x240 pixel GIF files	239
Audio	8-bit, mono, 22kHz WAV file (one minute audio)	1312
Video	320x240 MPEG file (one minute video)	9000

Table 3. Types of Media elements

In the development of EC4810 WBT course, only text, graphics and animations were used. This is to ensure that the application developed is relatively small in size for fast delivery over the Internet.

More complex media-rich elements such as audio and video require greater storage size and hence demand higher bandwidth. Most Web browsers also do not

natively support audio, video or sophisticated animations. To play these media-rich applications require a plug-in, to be installed in the users' Web browser.

Fortunately, rapid technical innovations is surmounting the bandwidth barrier of the Web and enabling the delivery of online content that is truly interactive. This chapter presents a discussion of recent developments in audio and video capability.

A. AUDIO CAPABILITY

Audio can enhance learning concepts and reinforce ideas presented as text or graphics on the screen. There are three types of audio assets that are commonly used in online learning:

- Music
- Narration
- Sound effects

Music requires high quality and wider sound frequency range than narration and hence produces larger files. Narration typically has a small sound frequency range and can be compressed more than music while retaining good sound quality. Sound effects are generally short so they do not have a large impact on the overall file size of an online course. Of the three audio types, narration is the most applicable in the design of ECE WBT courses.

For the purpose of recording narration, Microsoft Windows provides a readily available "sound recorder" program in its accessories. Select the application (as shown in

Figure 13) from the Windows *Start | Programs | Accessories | Multimedia | Sound Recorder* menu.

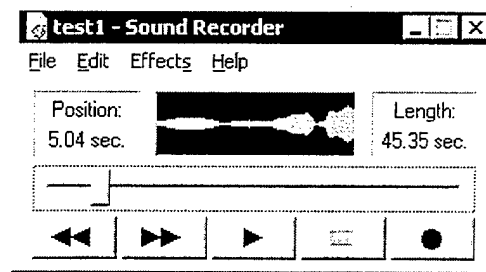


Figure 13. Sound Recorder from Microsoft Windows

A sound card and microphone need to be installed in the developer's computer in order to record audio files. A sample recording for the narration of the EC4810 online course introduction page was performed. The recording was 45 sec in length, with a total of 106 spoken words, to produce a stereo 16-bits 44 kHz WAV file of size 7814 Kbytes. In comparison, the entire Authorware WBT online course produced without audio effects (fourteen sections with three hundred over pages in total) was only 3804 Kbytes.

Clearly, the WAV audio format recording creates files that are too large to use in an online course. To decrease the size of audio files, audio editors can change the attribute of the file, such as lowering the bit depth from 16-bits to 8-bits, or lowering the sample frequency from 44kHz to 22kHz. Compression tools such as Microsoft Audio Compression Manager (ACM) are available in the market but require that certain files be installed on the user's machine. Even with this kind of compression tool, the resultant compressed audio files remain unusable. The previous recording of 7814 Kbytes after compression to a mono 8-bits 22 kHz WAV file produces a WAV file of 977 Kbytes, almost one-third the size of the entire Authorware online course.

With the advance of recent technologies, new compressed audio formats have been introduced, with the goal of balancing small file size with acceptable audio quality. Today, Authorware, Director and Flash all are packaged with internal audio compression utilities. Authorware and Director compress audio into streaming Shockwave audio (SWA) format, while Flash can compress audio into streaming MP3 standard format. Additionally, Authorware also includes a utility that compresses voice narration into the extremely compact VOX format. To activate the Authorware Voxware encoder, select it from the Windows *Start* | *Programs* | *Accessories* | *Macromedia Authorware 5* | *Voxware Encoder* menu as shown in Figure 14. Notice that the previous file after compression to the VOX format is only 16.69 Kbytes as compared with the 977 Kbytes in WAV format.

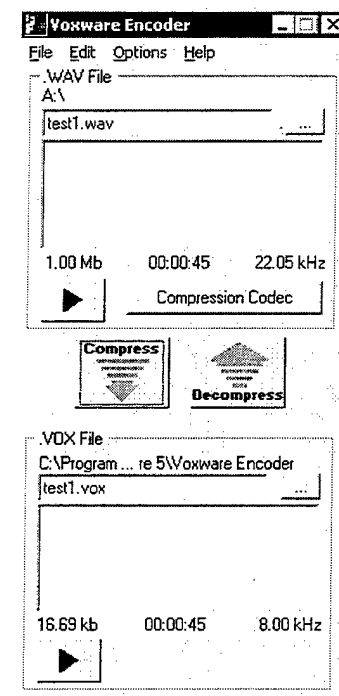


Figure 14. Authorware Voxware Encoder application window

It was noted that the quality of the audio has decreased after conversion to the VOX format, but it was still understandable. This was expected since the audio file size had decreased by approximately 60 times. Nevertheless, these are extremely compact audio files suitable for playing narration in an online learning course.

B. VIDEO CAPABILITY

Video can be useful for conveying certain information. Using video in online learning can help realistically demonstrate equipment and processes. The intricate level of detail visible in video is also ideal for illustrating subtle or nonverbal information. In particular, ECE lectures explaining complex mathematical formulas or electronic circuits can be recorded, digitized and broadcasted live over the Web. Students enrolled in distance learning can access the Internet at scheduled lecture times and attend the classes real-time. These recordings can then be saved and hosted on the WBT Homepage for students to access at any other time to review difficult concepts. As users view the online video, questions can be easily recorded and send via email to the lecturer for comments. These questions and answers can be compiled as Frequently Asked Questions (FAQ) and documented on the WBT Homepage for future reference.

There are three standard digital video formats, namely QuickTime Movies (MOV files), Video for Windows (AVI files) and the standard movie format (MPEG files). Digital video tends to be large so they are not appropriate for delivery on modem connections. Because of the size (see previous Table 3), video files are never imported into an authoring tool [Ref. 4]. In fact, most authoring software has no internal video

compression capability. Video is captured, edited and optimized externally using video editors such as Adobe Premiere. Just as with audio, varying file parameters such as the frame rate, the presentation window size, and the number of colors in the palette can decrease video file size. Even with a well-compressed video, it is an order of magnitude larger than standard audio WAV files.

Web servers have traditionally been defined as “stateless” [Ref. 14]. That is, the Web server handles a request for information by pushing all the data out as fast as possible, completes the transaction, disconnects and proceed to service other request. On the client side, the Web browser receives all the information and then assembles it on the screen. This stateless approach works very well for media like text and graphics. But audio and video often comes in a larger file size. Under the stateless approach, a Web user would need to download the entire video clip before it can be viewed. But, with the large file size that comes with even a short video clip, the wait can be unbearable.

Streaming media is the latest technology that has emerged to overcome this limitation of the World Wide Web to handle video. Using Internet technologies that are mostly proprietary, media-rich data can be fed to the user as the media is viewed. Rather than a stateless data connection (whereby all data are transmitted before being played), streaming media is more of a continuous connection (whereby users receive audio or video just before hearing or seeing them). Paced out over time, the file size of the video clip becomes less of an issue. Nevertheless, streaming compression techniques are still used, simply because the raw file sizes of digital video are absolutely huge.

The three leading streaming media player today are Windows *Media Player 7*, Apples *QuickTime 4*, and RealNetworks *RealPlayer G2*. The de facto standard for streaming media seems to be RealNetworks. One of the advantages of the G2 player is that it supports a new RealNetworks technology called "SureStream" [Ref. 14]. This technology dynamically adjusts the quality of the signal during playback by sending the signal that makes the most sense depending on bandwidth. If the available bandwidth drops, the signal quality shifts down to match. This transition is usually very smooth and does not disrupt the user's experience.

The future of streaming is in offering the user a sophisticated multimedia experience. To enable simple authoring of TV-like multimedia presentations, the World Wide Web Consortium (W3C) has designed the new Synchronized Multimedia Integration Language (SMIL, pronounced as "smile") [Ref. 15]. Introduced in June 1998, SMIL is an easy to learn HTML-like language, and is tailored for composing presentation using streaming audio, video, and any other media type. Much like early HTML, it has a long way to go. Current SMIL authoring tools are usually buggy. But as the language develops, it will enable streaming media to replace the world of stagnant Web design, making a richer multimedia experience possible on the Web.

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V. CONCLUSIONS

The undertaking of this thesis project has provided the author with many learning opportunities of the World Wide Web and its associated technologies. In particular, Web-based teaching and learning of ECE courses were investigated. The results were the design and development of a WBT online course and Web page for the EC4810 Fault Tolerant Computing course. A step-by-step guide for creating new courses and for future maintenance was formulated in the process (Presented in Appendix A and B). These products need to be continuously updated to keep pace with new information and evolving Web technologies. One area of consideration was the incorporation of audio and video in WBT courses.

Three research questions were posted in the beginning. At the completion of this thesis work, the response to these questions is as follows:

1. Which recent Web technology is the most suitable for production of WBT ECE courses?

Several recent technologies were investigated in this thesis. Their advantages and disadvantages were examined and presented in Chapter II. At the time of this study, it was concluded that COTS authoring tools were the most appropriate technology for the development of ECE WBT courses. The decision was based on productivity, interactivity, maintainability, and cost effectiveness.

Further research identified Macromedia Authorware 5.2 as the preferred tool for use in creating the WBT online course, on the merits of its many powerful interactive features and the short learning curve needed to use it.

For the design and development of the EC4810 Homepage, Microsoft FrontPage 2000 was the obvious choice due to its availability, user-friendliness and compatibility with other Microsoft products.

2. To what extent are guides suitable for the creation and maintenance of online courses?

With careful design and diligent work, one can produce online courses that harness the benefits of Web technology. However, converting traditional courses to effective online learning requires much time, technique and talent. This thesis investigated and introduced a time-saving technique in developing effective WBT courses by incorporating a step-by-step guide. Subsequently, this guide was used in developing other websites and online courses. The results showed that design and development time has decreased by more than 50%. It is clear that the systematic guide had significantly facilitated the creation of new WBT course production. It is recommended that the author's project template and guide be used for future development.

3. Are audio and video matured for incorporation to WBT courses?

Until recently, most WBT online courses are created using text, graphics or animation based only. This was due to the unacceptably huge file sizes of audio and video

files, plus the fact that Web technologies have traditionally been using stateless data connections.

With new innovations in compression techniques, such as the Authorware's Voxware Encoder, file sizes of media-rich elements can be reduced significantly. The introduction of streaming media technology has also moved the Internet towards continuous data connection applications. Further advances made in hardware and network technology have facilitated the availability of higher bandwidth Internet communications at a lower cost.

New languages, technologies and approaches in streaming media have now made audio and video applications ready for incorporation to WBT online courses. Great potentials exist in employing sophisticated media-rich elements to design and develop truly interactive multimedia online applications. The final barrier - designer's creativity.

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APPENDIX A. STEP-BY-STEP GUIDE FOR CREATING ONLINE COURSE

This example uses the step-by-step guide to create a new online course for EC3840 Introduction to Computer Architecture.

Step 1

Copy the directory H:/EC4810 Authorware Design to a new directory and rename it (i.e. EC3840 Authorware Design) using Windows Explorer as shown in Figure A1.

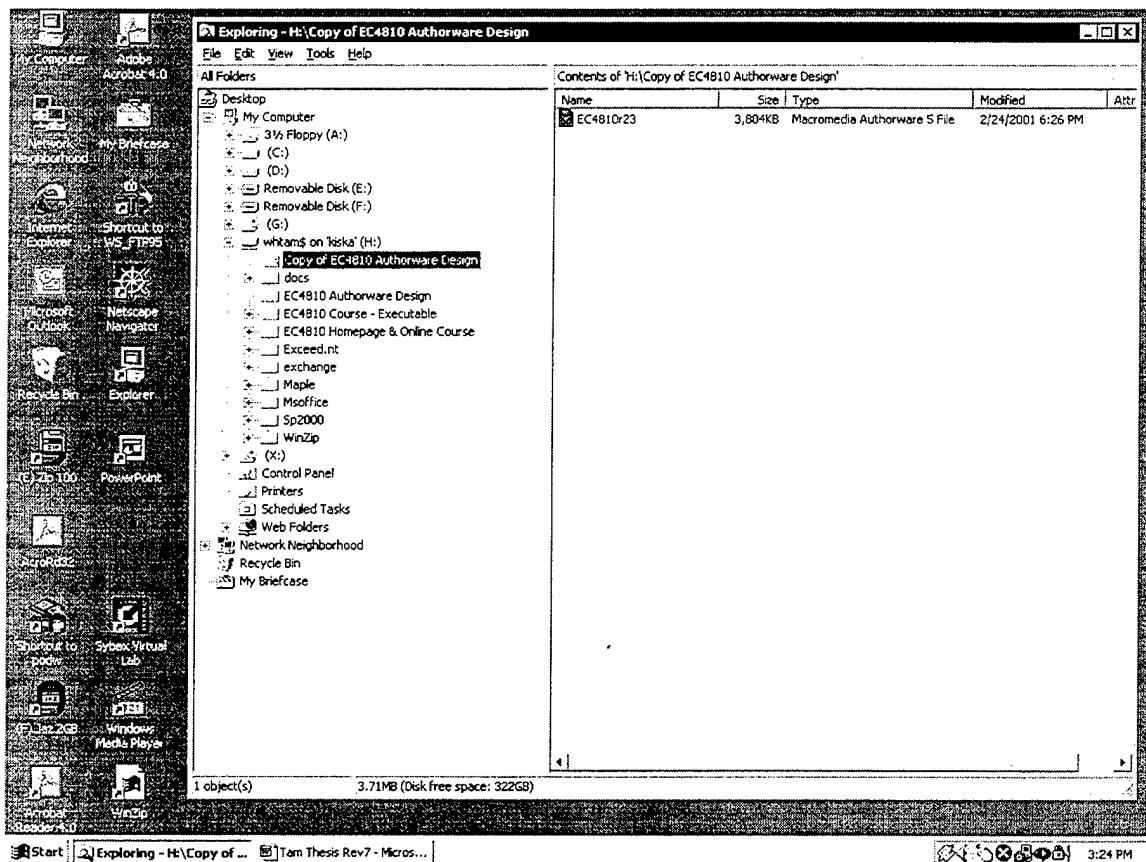


Figure A1. Copy the Authorware design template to another directory using Windows Explorer

Step 2

In the new directory, rename the filename EC4810r23 to EC3840r01 as shown in Figure A2. The file extension of these Authorware design files is .a5p (which cannot be seen clearly from the Windows Explorer).

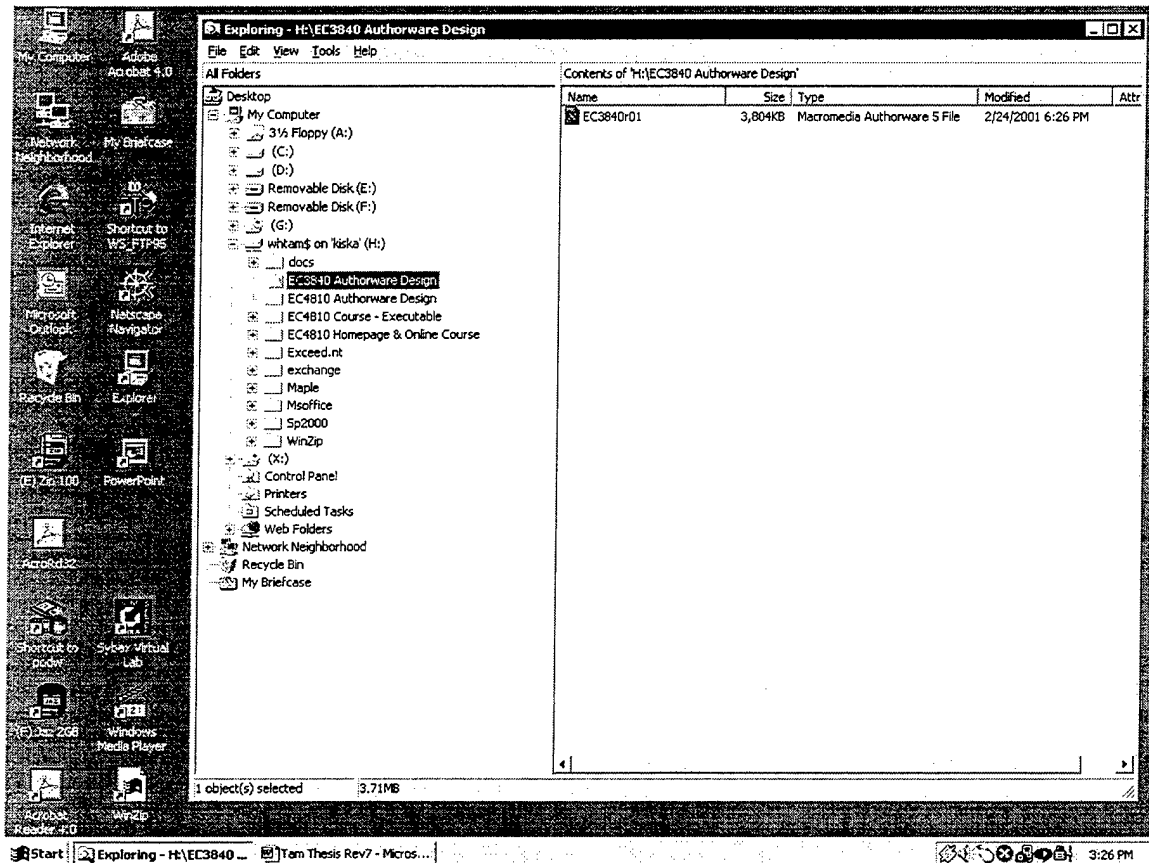


Figure A2. Rename the Authorware design file

Step 3

Double click on the new file EC3840r01.a5p and the Macromedia Authorware application software will launch as shown in Figure A3. This assumes that the application software has already been installed in the computer.

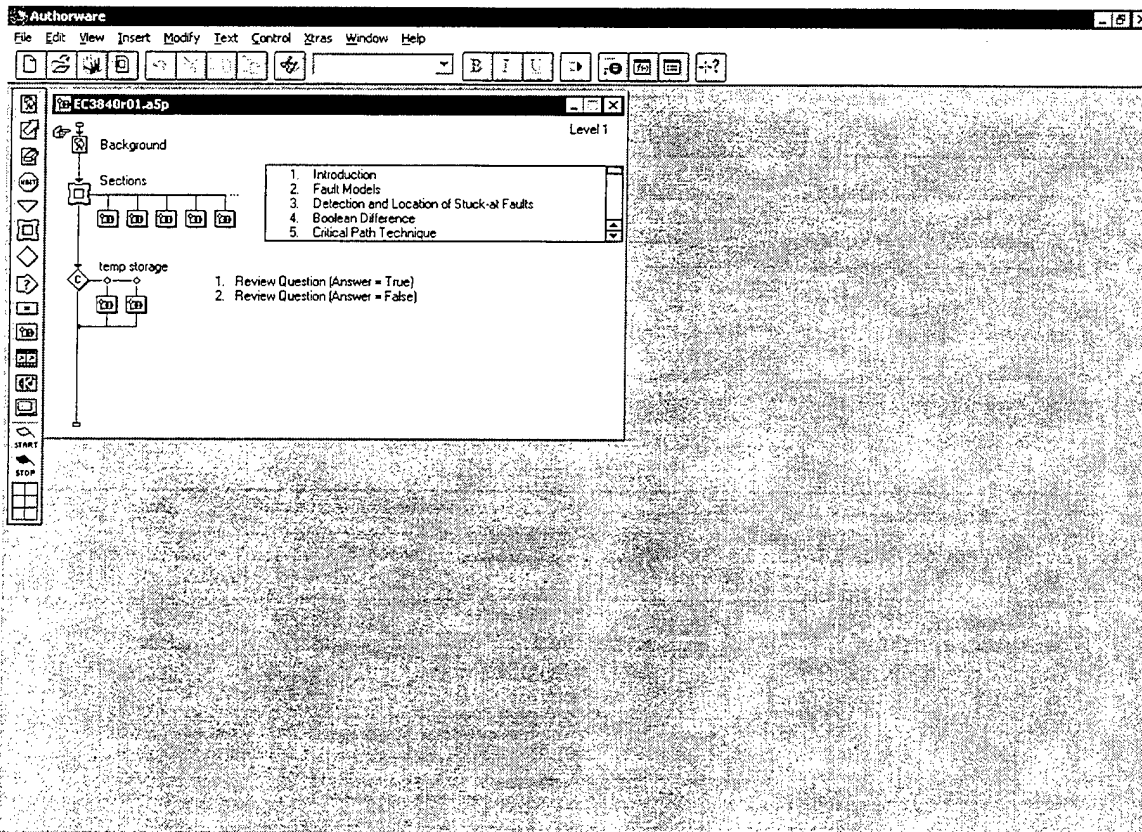


Figure A3. Macromedia Authorware application software

Step 4

Click on the **Restart** button of the **Toolbar** menu to launch the Presentation Window as shown in Figure A4. In this Presentation Window, the program will run like an executable online course. However, all mouse clicks must be single click only. A double click anywhere in the Presentation Window will switch to the Design mode. To return to the executable mode at any time, click on the **Restart** button again.

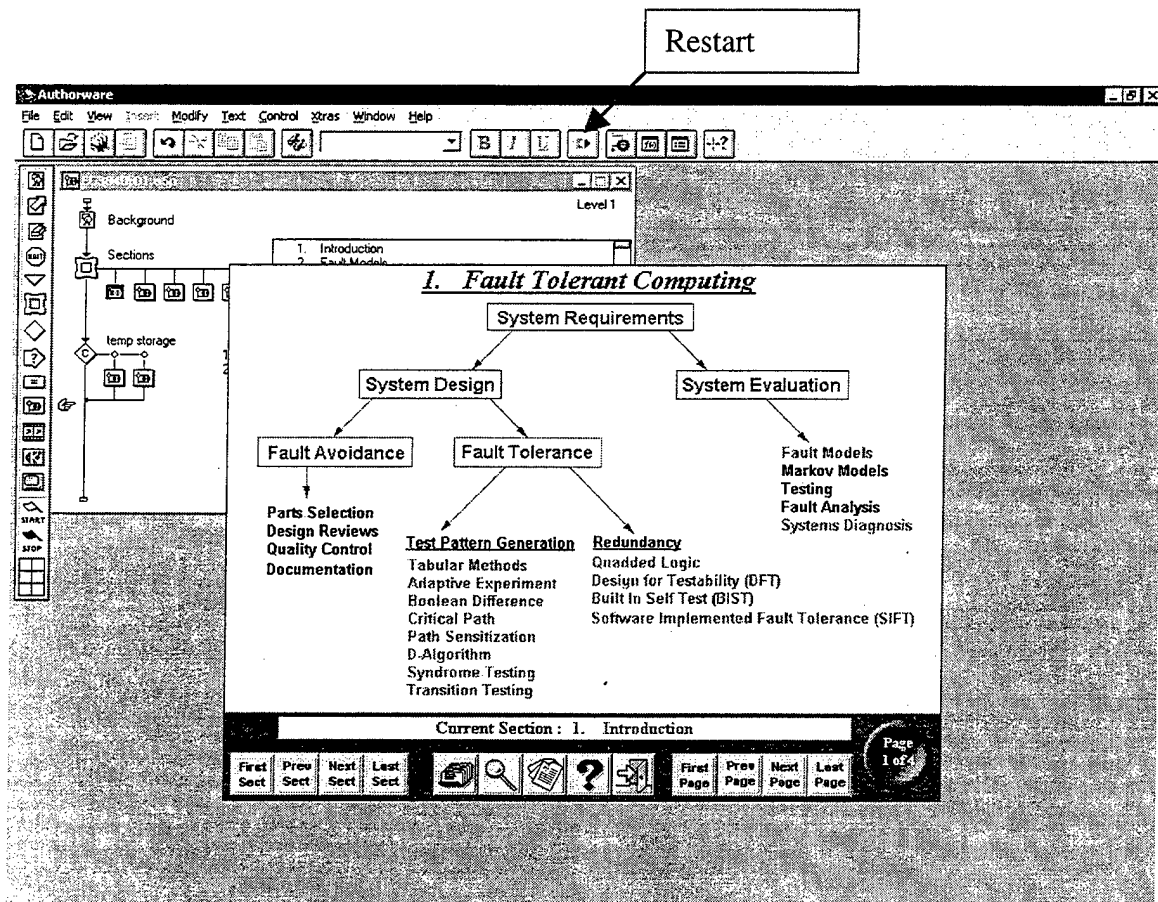


Figure A4. Presentation Window where the online course can be previewed

Step 5

To begin editing the contents of the new course, double click on the Design Window. This will bring the Design Window to the front. Single click on the first Map icon along the horizontal flowline and the words “1. Introduction” will be highlighted. Place the cursor on the highlighted words and edit as necessary. Double click on the same Map icon and a new window for Section 1 on Introduction will pop-up as shown in Figure A5.

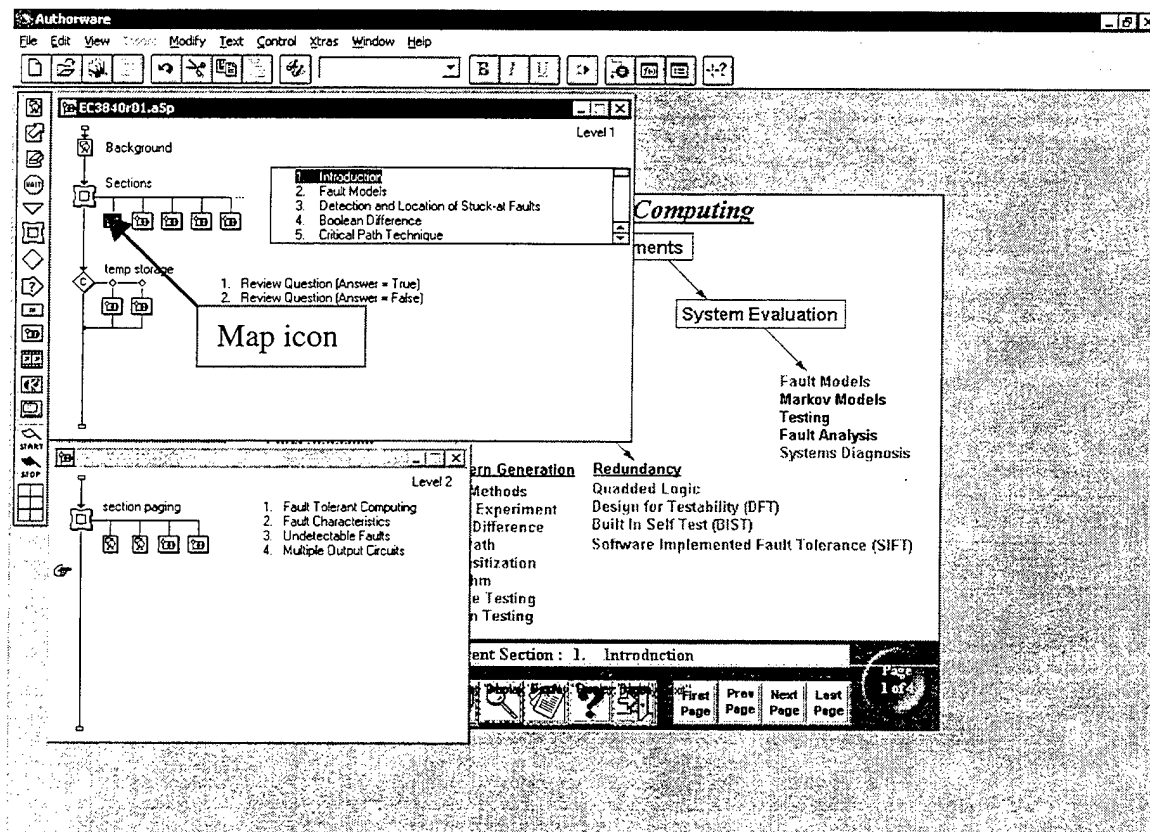


Figure A5. Design Window to edit the contents of the course

Step 6

All the Design Windows that pop-up can be moved to any location within the Authorware main window. To make changes to the first section, single click on the Display icon of the Section 1 window and the words “1. Fault Tolerant Computing” will be highlighted. Place the cursor on the highlighted words and edit as necessary as shown in Figure A6.

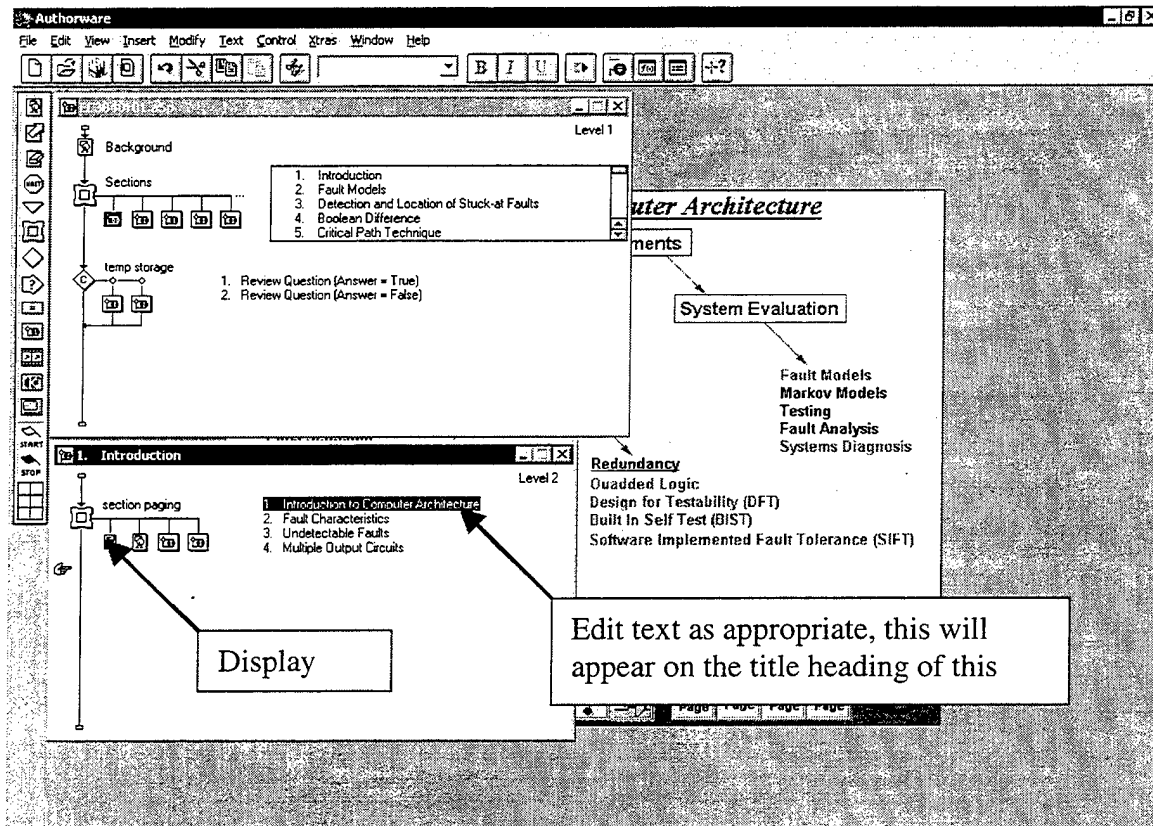


Figure A6. Rename and edit individual page titles as appropriate

Step 7

Once the name of the individual pages has been updated, double click on the same Display icon (see Figure A6) and the Presentation Window will be brought to the front as shown in Figure A7. This is the design mode, and various pop-up control panels will also appear to enable the selection of different properties needed in the design. The Toolbox menu provides tools to create text and simple graphics, and to arrange graphic elements on the screen. The other four panels set the properties of lines, fills, modes and colors of the text and graphic elements on this page.

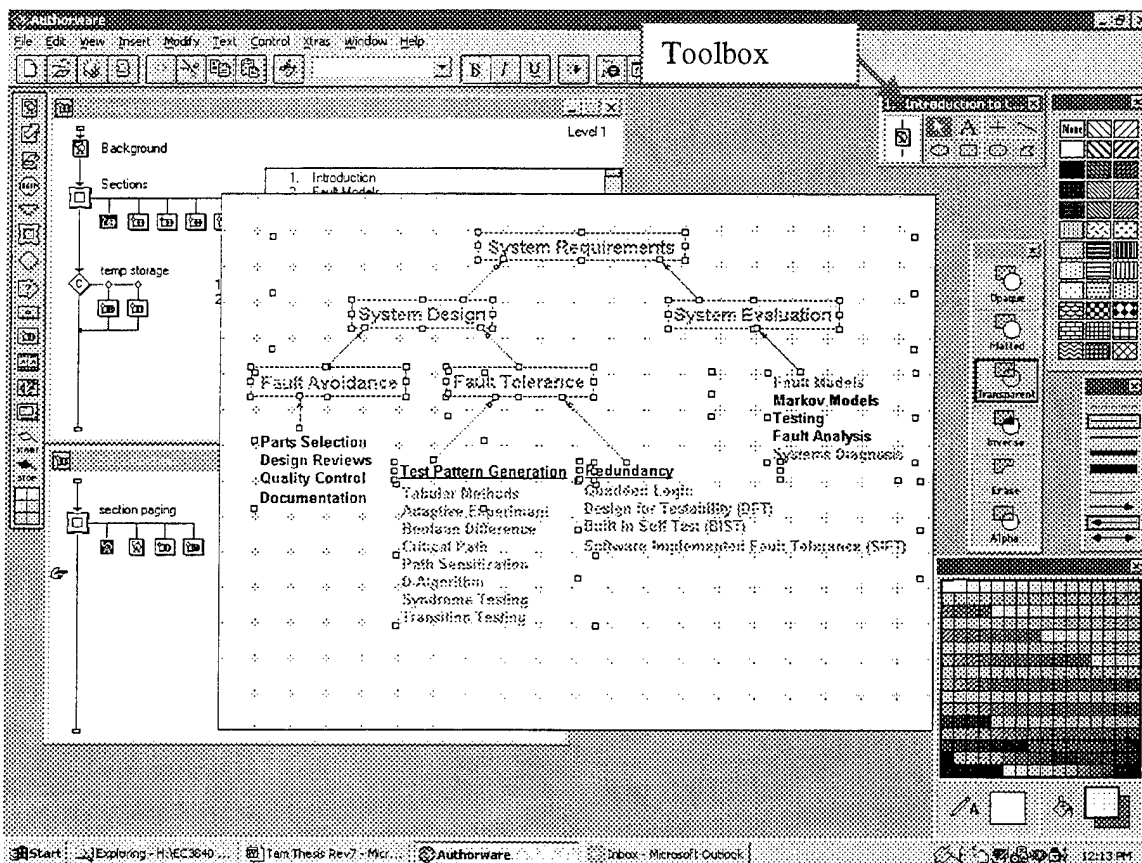


Figure A7. Edit the contents of individual pages

Step 8

With the Toolbox menu set at the Pointer mode, objects on the screen can be selected and moved around as shown in Figure A8. To select a single element for editing, single click on it such that tiny white square boxes appear at the corner of the element. To select multiple elements, left click on the mouse and drag a window over all the elements. To *Group* or *Ungroup* elements, select from the *Modify* menu.

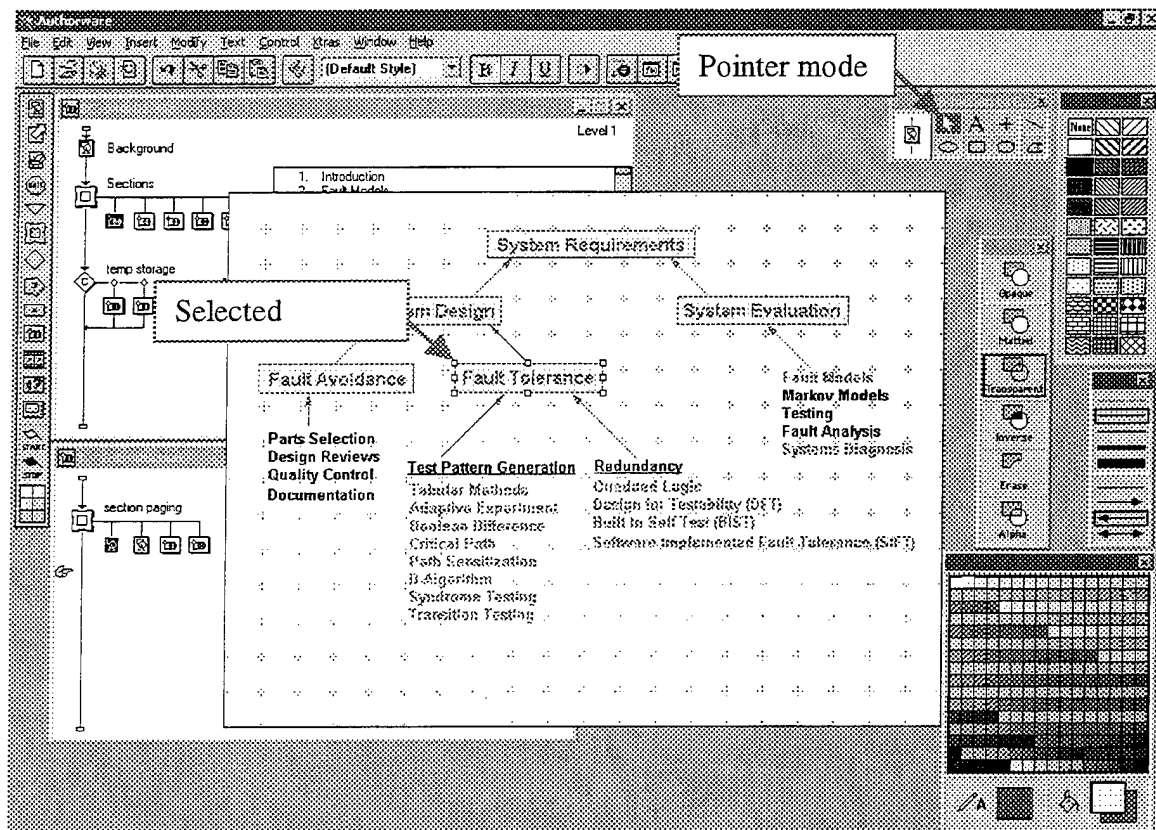


Figure A8. Toolbox set at Pointer mode

Step 9

With the Toolbox menu set at the Text mode, text on the Presentation Window can be created or modified. The font sizes, types, colors, etc. can be changed using the pop-up menu and from the Text menu as shown in Figure A9.

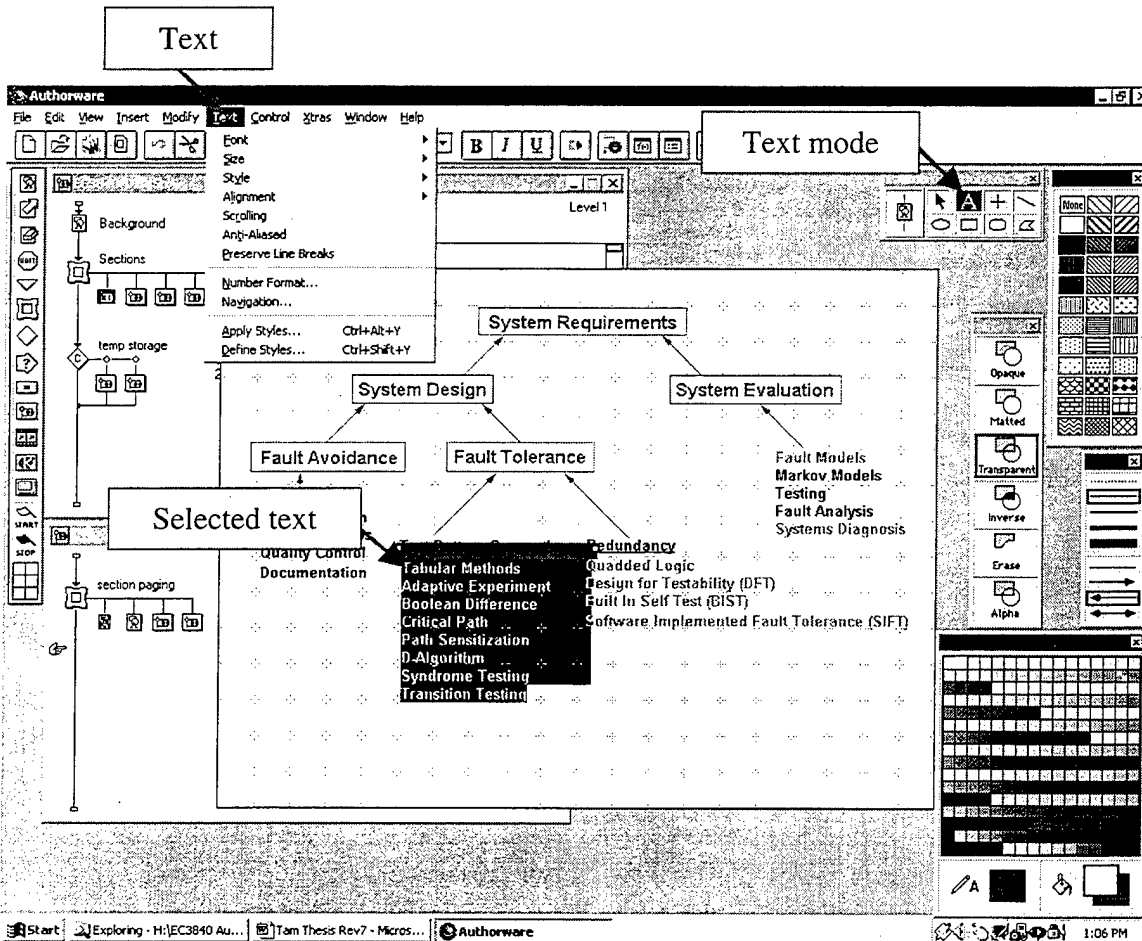


Figure A9. Toolbox set at Text mode

Step 10

To copy text from an external software such as PowerPoint or Word, the Authorware program must first be set at the Text mode in the Toolbox menu. Toggle to the external program to copy the necessary text into the clipboard for importing. Toggle back to the Authorware program and position the cursor where the imported text is to appear. Select Edit | Paste or Ctrl-V to copy and paste the text from the clipboard. A pop-up window as shown in Figure A10 will appear. Select Ignore and Standard button, then click OK to complete the process

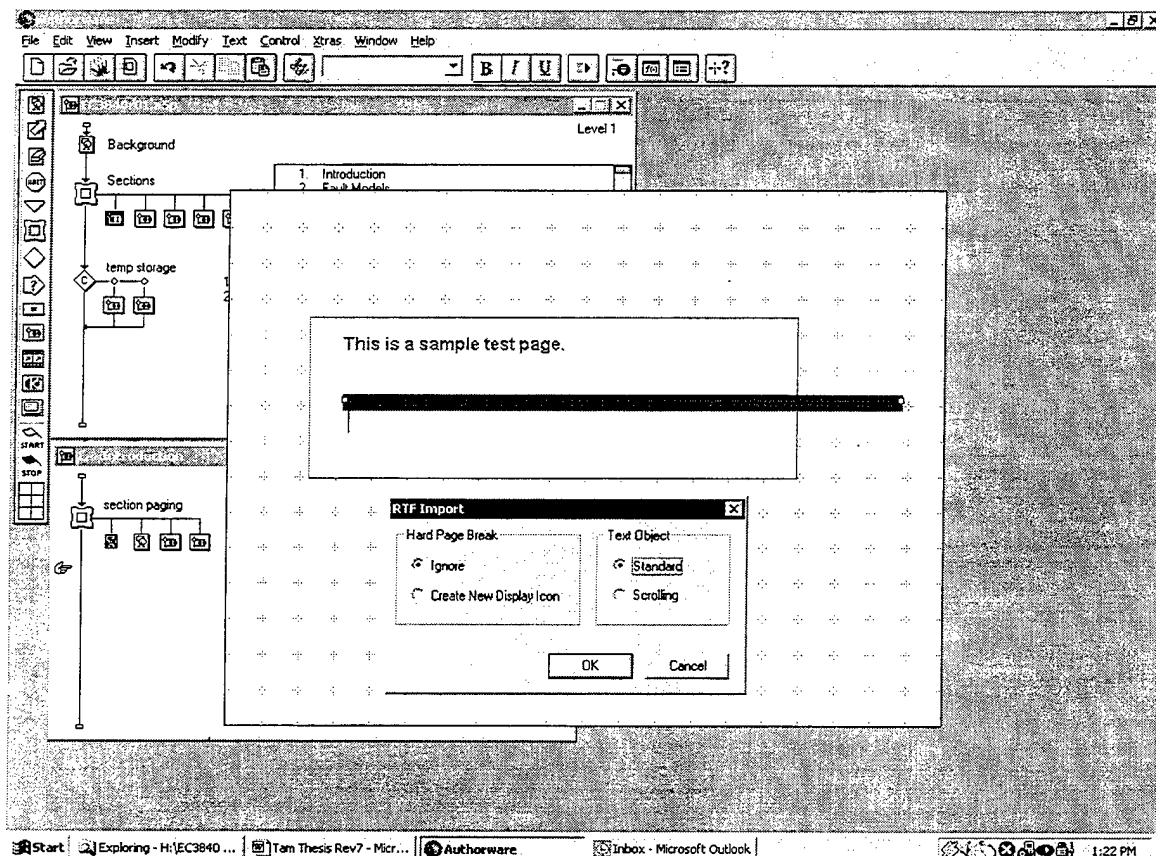


Figure A10. Import text from external programs

Step 11

To view the final effect, click on the **Restart** button as in Step 4 to refresh the Presentation Window. See Figure A11. Note that the Find feature of added or deleted text is automatically updated (see Step 14).

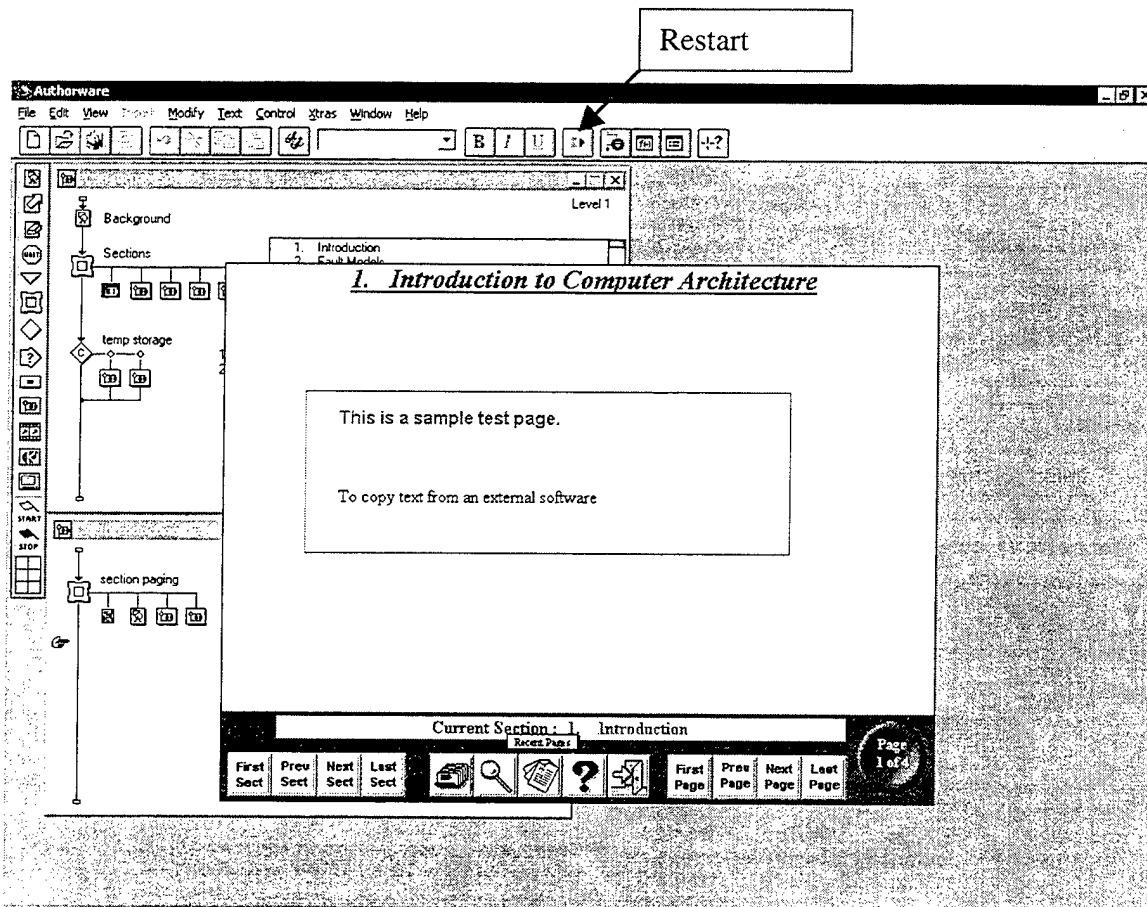


Figure A11. Refreshed Presentation Window to view effects of design

Step 12

Click on the button with a big “?” at the bottom of the Presentation Window. This is the help menu designed for this template as shown in Figure A12. The buttons for navigation between the different sections and pages on the left and right respectively is self-explanatory.

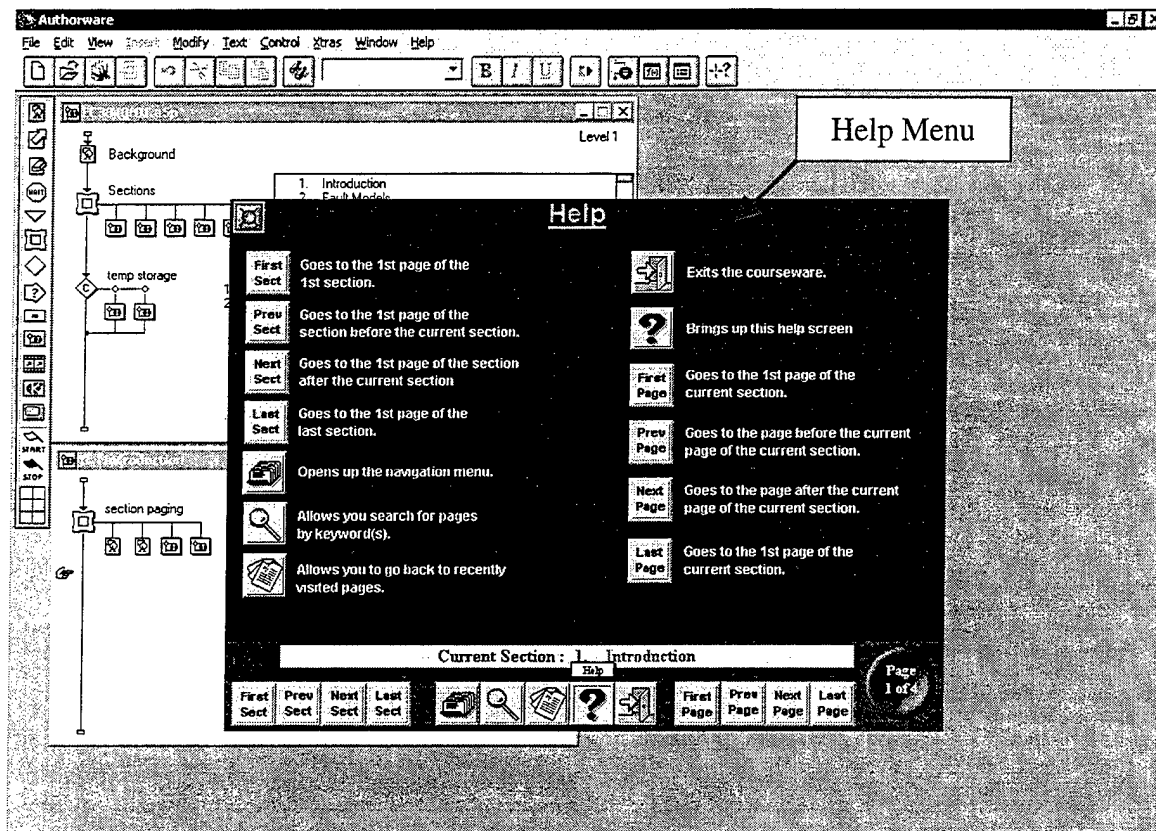


Figure A12. Help menu for the designed template

Step 13

Click on the “Menu” button at the bottom of the Presentation Window and a pop-up window will appear as shown in Figure A13. This is the Navigation Menu and helps users to jump to the page of interest directly. Click on the “+” or “-” in front of each section heading to expand or shrink the sub-headings respectively. To jump to a particular page, simply click on the corresponding sub-heading. Note that this Navigation Menu is automatically generated as pages are added or deleted from the Design Window.

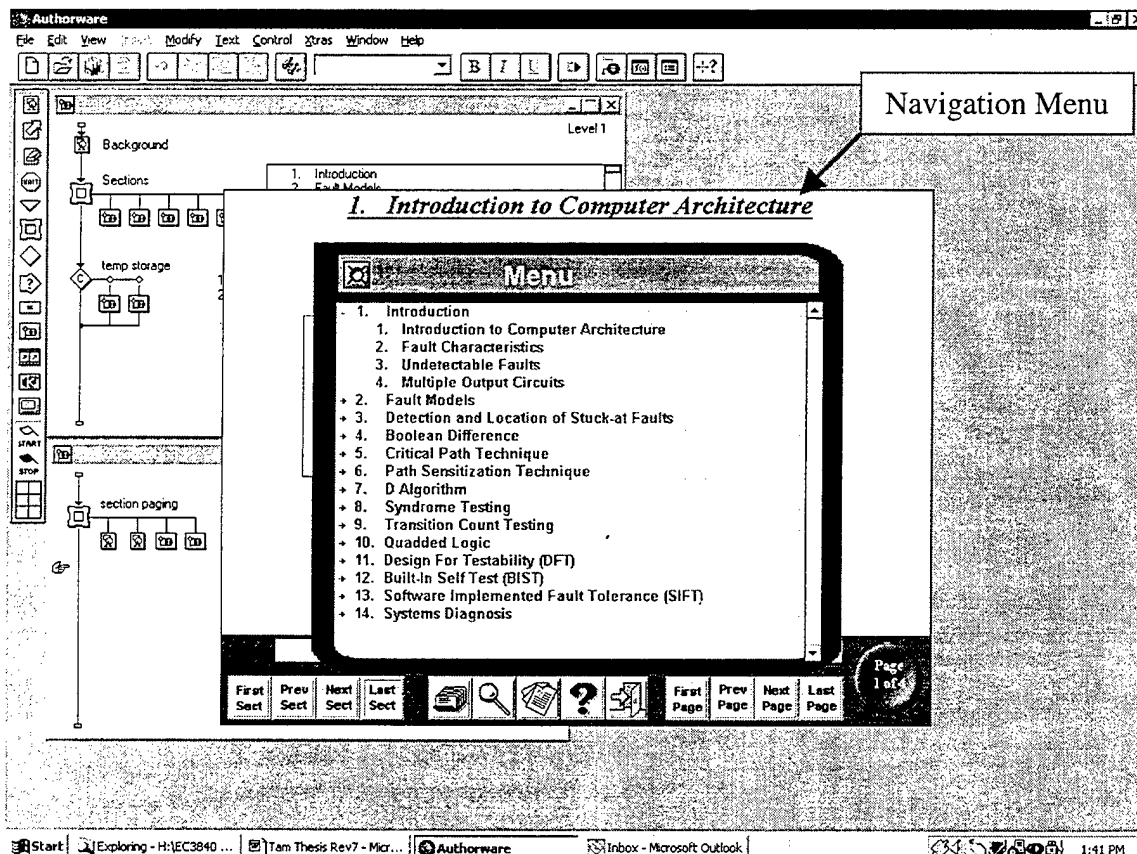


Figure A13. Navigation menu

Step 14

Click on the “Find” button at the bottom of the Presentation Window and a pop-up window will appear as shown in Figure A14. This is the Find menu and helps users to find a particular key word or phase within the entire online course, and go to the desired page directly. This feature is automatically generated whenever new text is added or old text deleted from the Presentation Window.

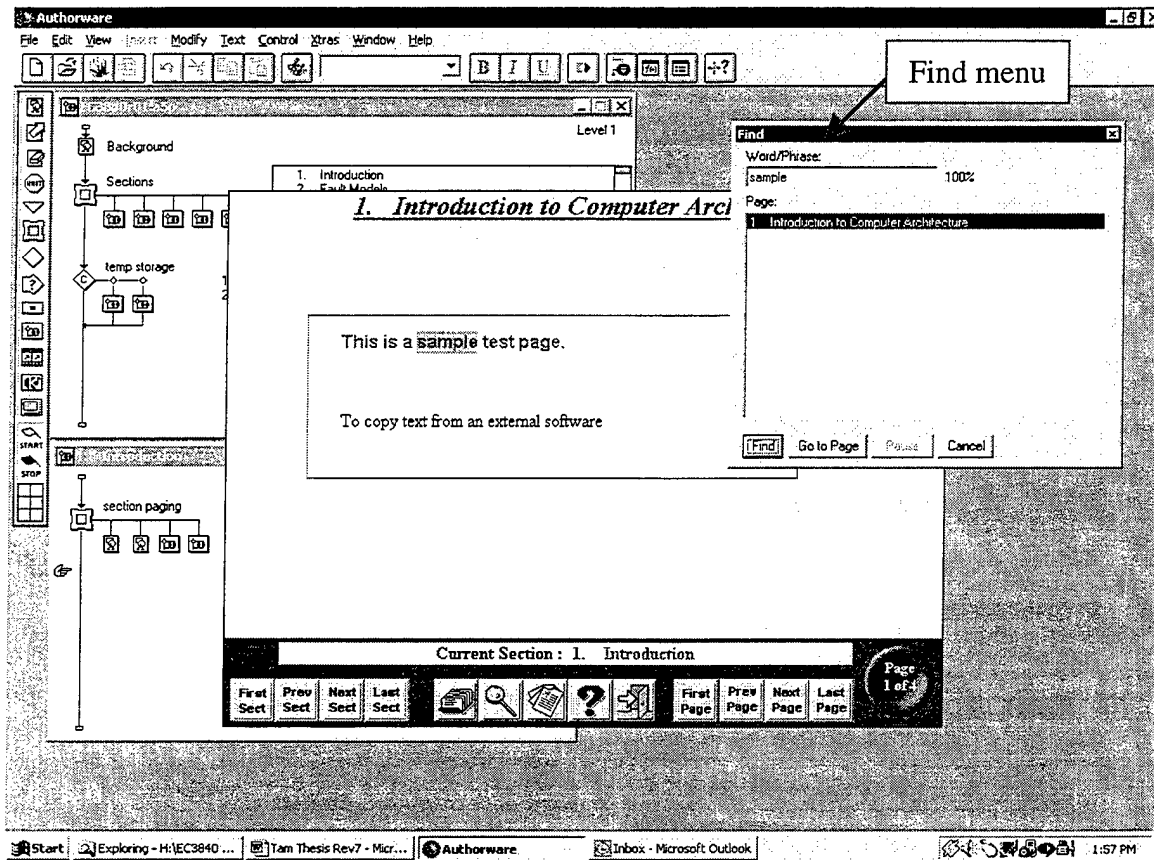


Figure A14. Find menu

Step 15

Click on the “Recent Pages” button at the bottom of the Presentation Window and a pop-up window will appear as shown in Figure A15. This is the Recent Pages menu and helps users keep track of the most recently visited pages. It allows a direct jump to a particular page by double clicking on any line in the Recent Pages list. This feature is automatically updated.

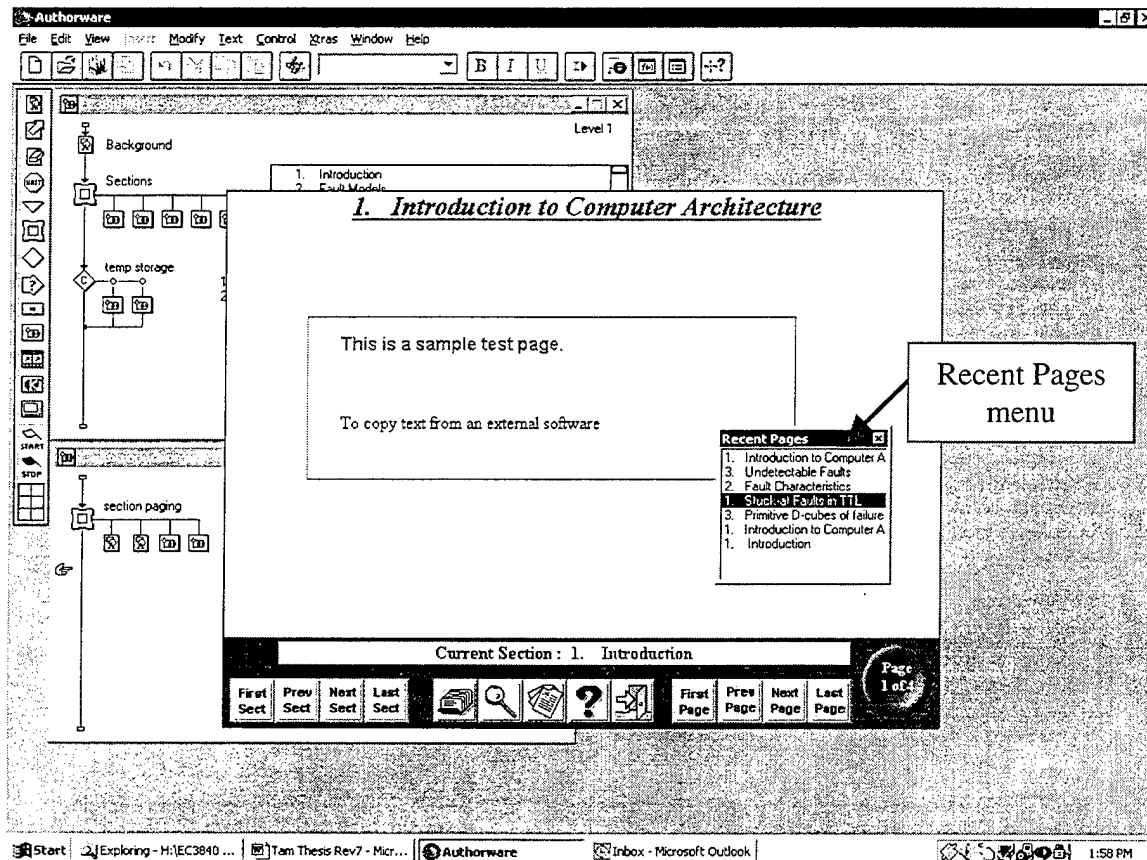


Figure A15. Recent Pages menu

Step 16

Click on the “Exit” button at the bottom of the Presentation Window and the online course will end. Before automatically closing the Presentation Window, a thank you for using this online course message will appear as shown in Figure A16.

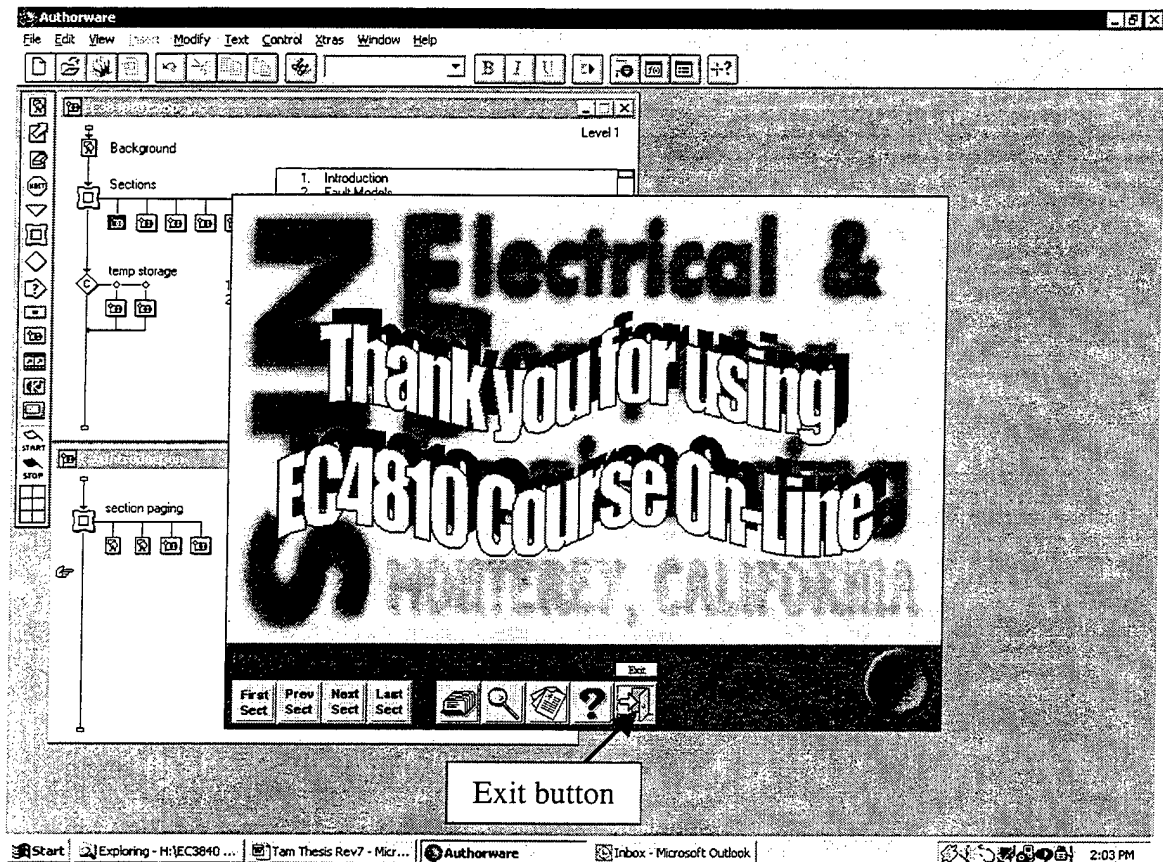


Figure A16. Exit button

Step 17

To edit the exiting page background and ending message, return to the main Design Window. Click on the Framework icon as shown in Figure A17 and a new Design Window appears. This is the Entry and Exit level page. On the Exit level 1 page below, double click on the “ECE dept background” Display icon or the “Thank you note” Display icon to change the exiting page background and ending message respectively. Graphics used for these pages are generated externally and imported using PowerPoint or any other editing software.

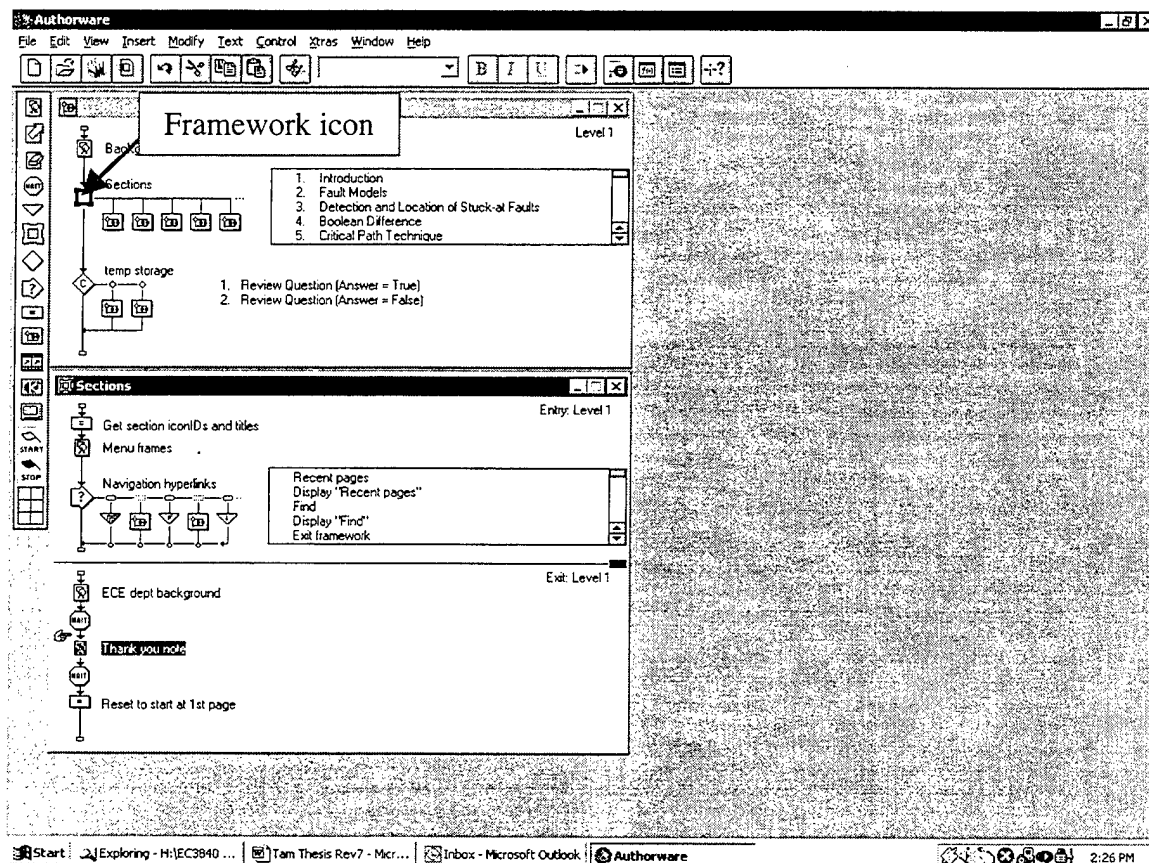


Figure A17. Change the Exit page background and ending message

Step 18

To add True/False questions at the end of each section, copy a standard question template from the main page and paste on the section page as necessary. Note that the question template has two versions, one with the answer as True and the other with the answer as False. Subsequently, change the title of the question appropriately (i.e. 5. Review Question 1) as shown in Figure A18.

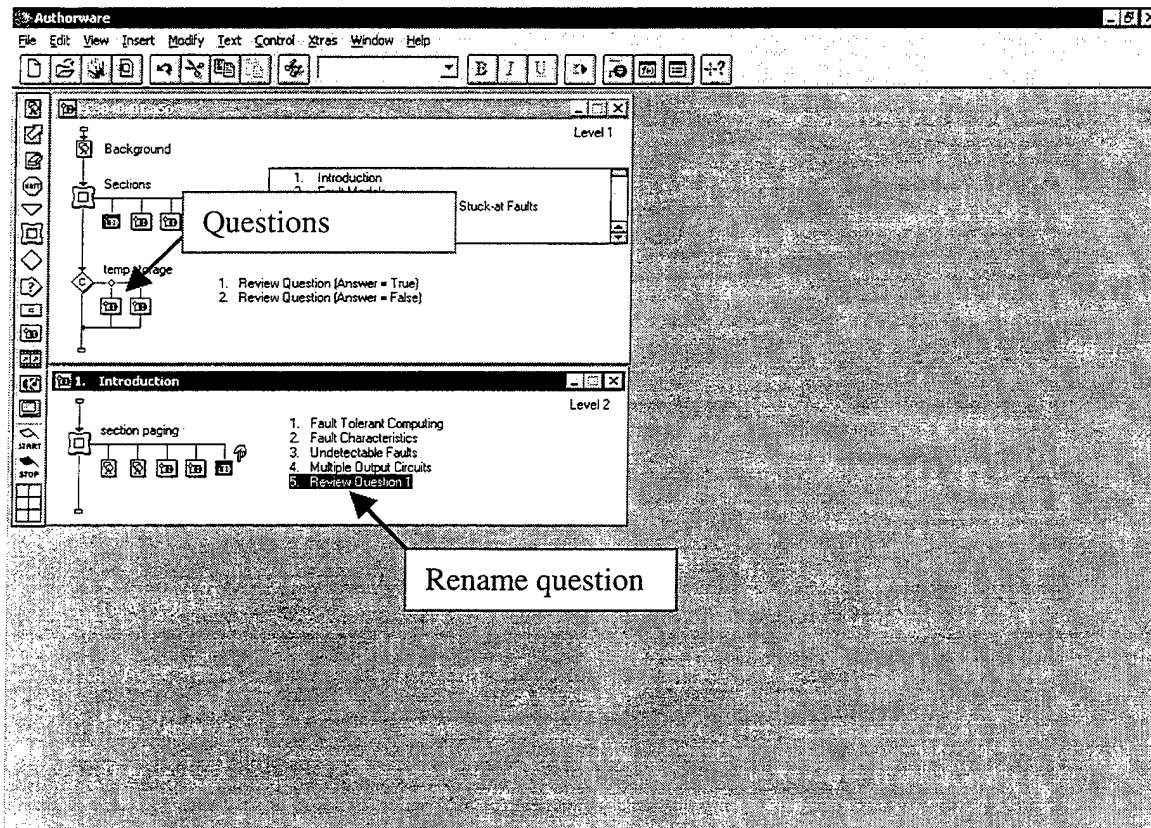


Figure A18. Change the Exit page background and ending message

Step 19

Next double click on the Map icon of the question and a new Window will appear as shown in Figure A19. Rename the pages as necessary to avoid duplication with questions in other sections.

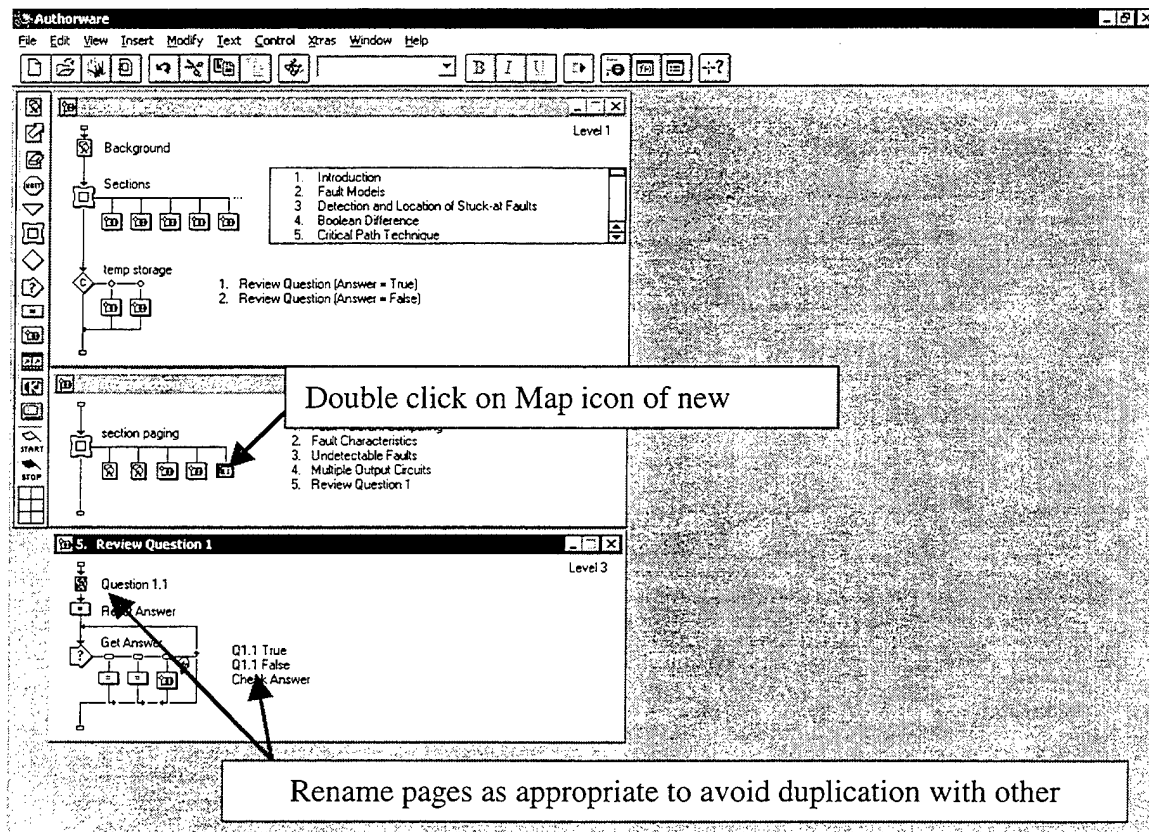


Figure A19. Rename question pages to avoid duplication

Step 20

Finally, double click on the Display icon as shown in Figure A20 to edit the content of the new question.

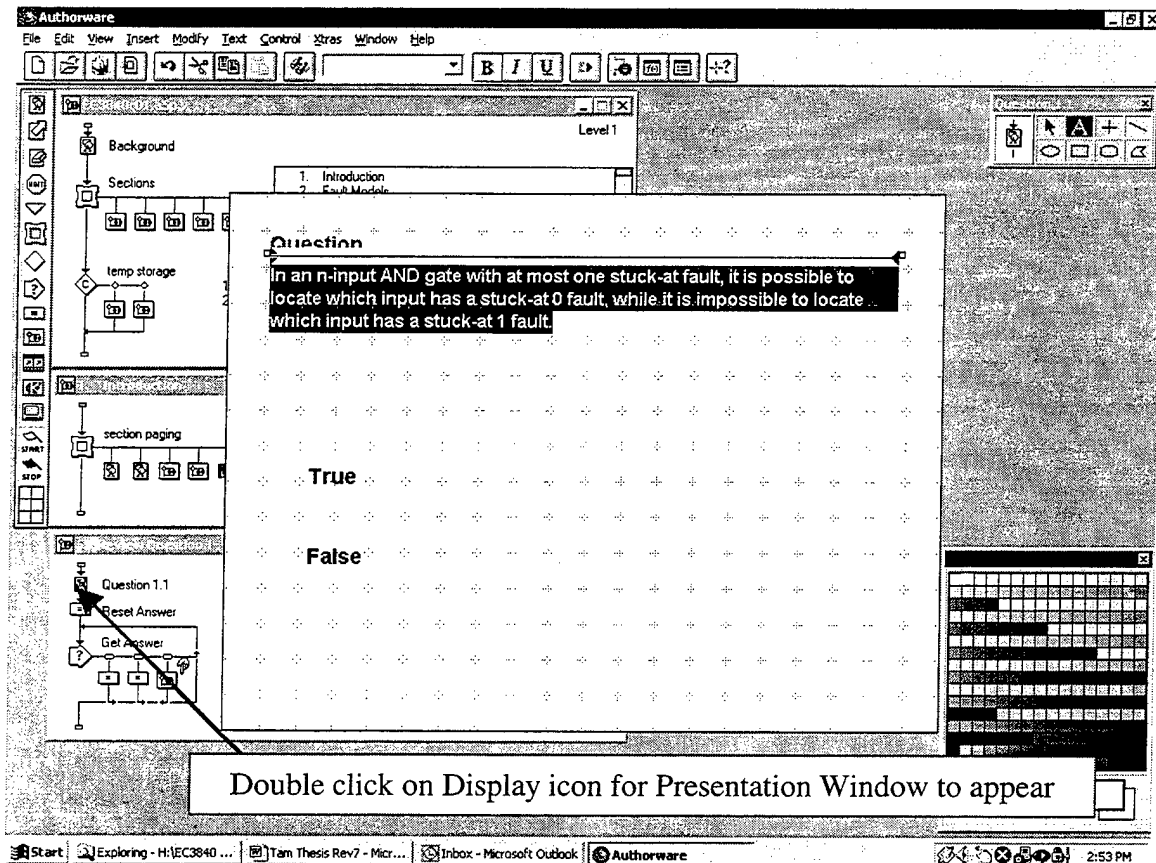


Figure A20. Edit content of the new question

Step 21

To view the final effects, click on the **Restart** button as in Step 4 to refresh the Presentation Window. See Figure A21.

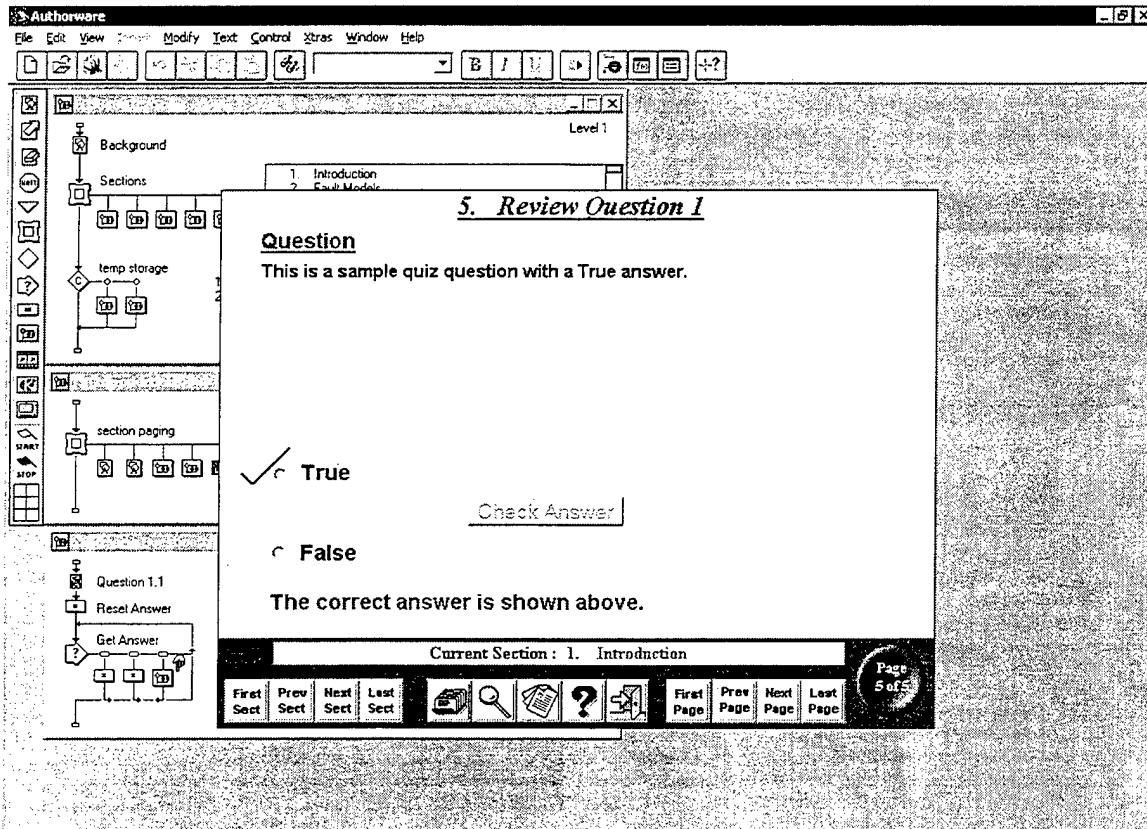


Figure A21. Review the presentation effect of the new question

Step 22

Once satisfied with the Online Course design, exit from Authorware by selecting File | Exit. Remember to save all changes before exiting. When closing the application, Authorware will prompt you if you have made recent changes to a page and have not saved it yet. See Figure A22.

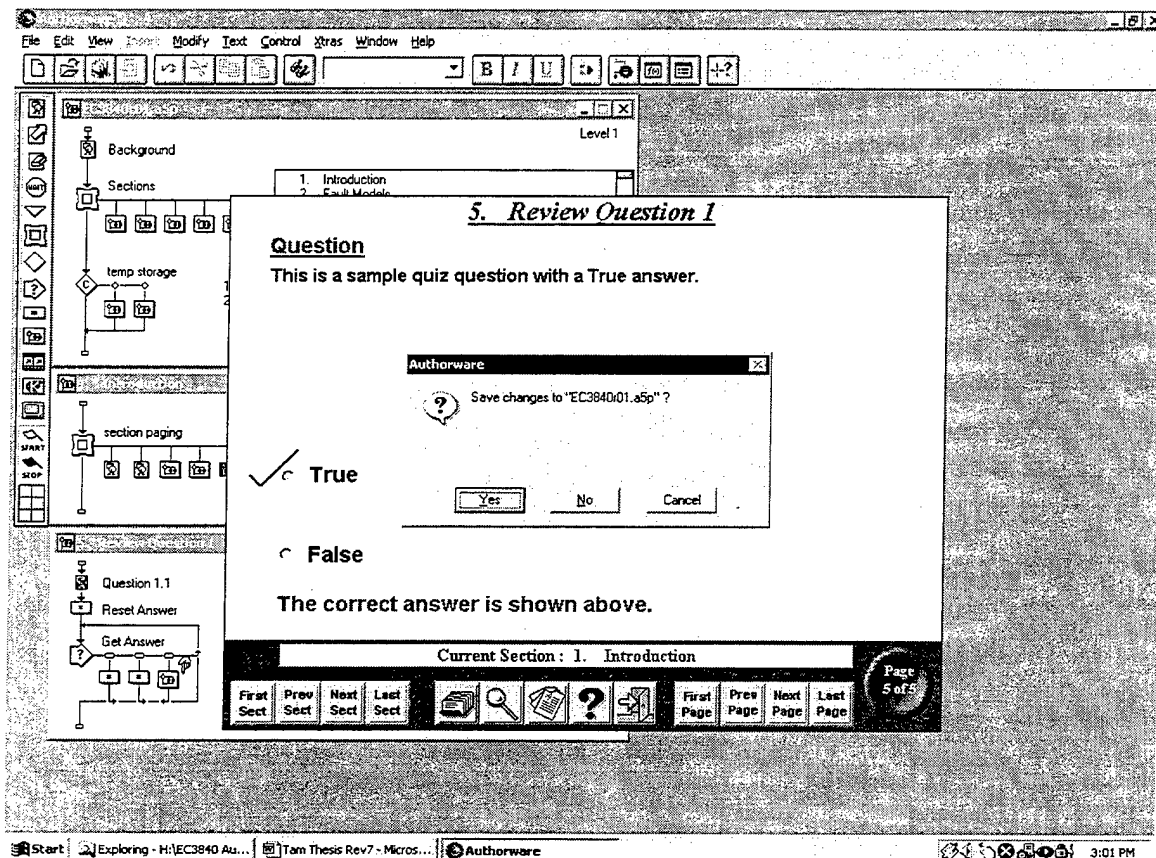


Figure A22. Save all changes before exiting Authorware

Step 23

The Authorware file needs to be compiled and packaged for distribution. To package as a standalone executable file, first copy the directory H:/EC4810 Course - Executable/ to a new directory and rename it (i.e. EC3840 Course - Executable/) using Windows Explorer as shown in Figure A23. Next, erase the EC4810 - Executable from the directory.

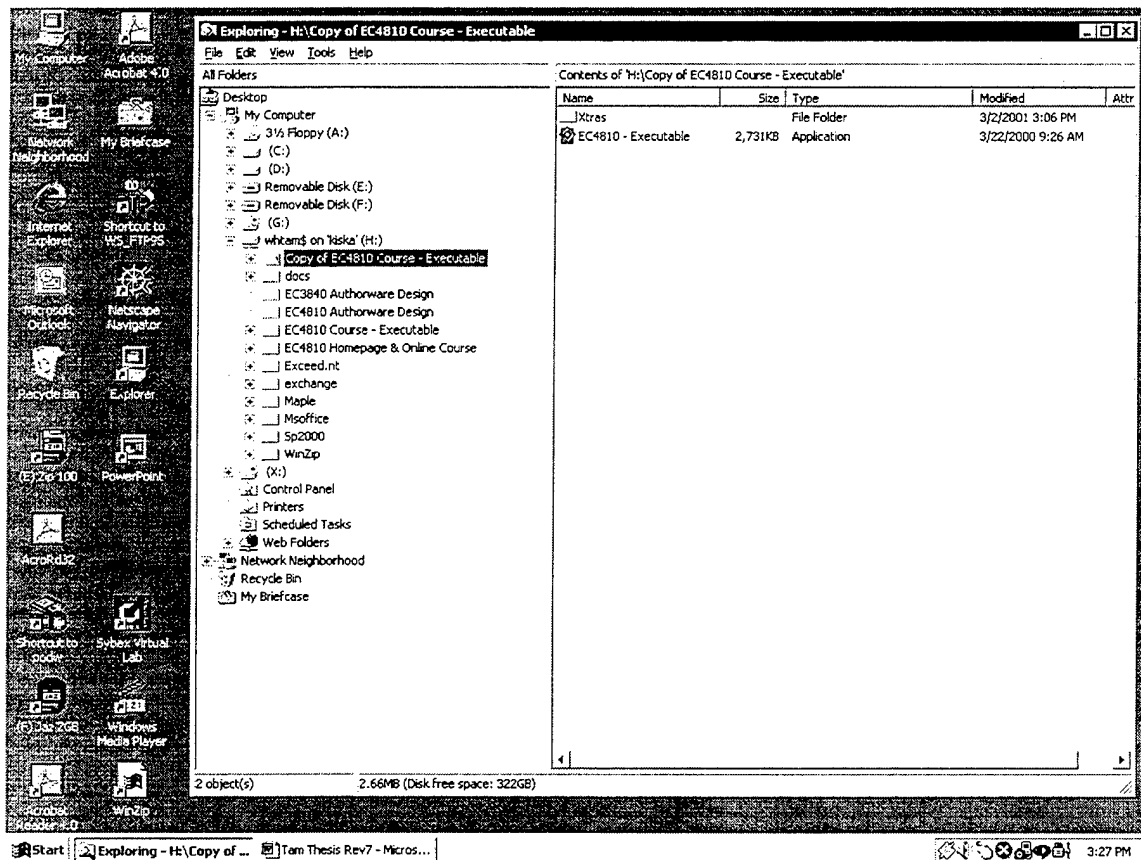


Figure A23. Create a new directory to package an executable file

Step 24

Launch the previously saved Authorware file from the H:/EC3840 Authorware Design/ directory again. Click on the **File | Package** and a new window will appear as shown in Figure A24. Select the “For Windows 95, 98 and NT” option as well as the “Package All Libraries Internally” and “Package External Media Internally” options. Click **Save File(s) & Package** button to begin the packaging process. Another window will appear to request destination of packaged file, select the H:/EC3840 Course – Executable/ directory previously created in Step 23.

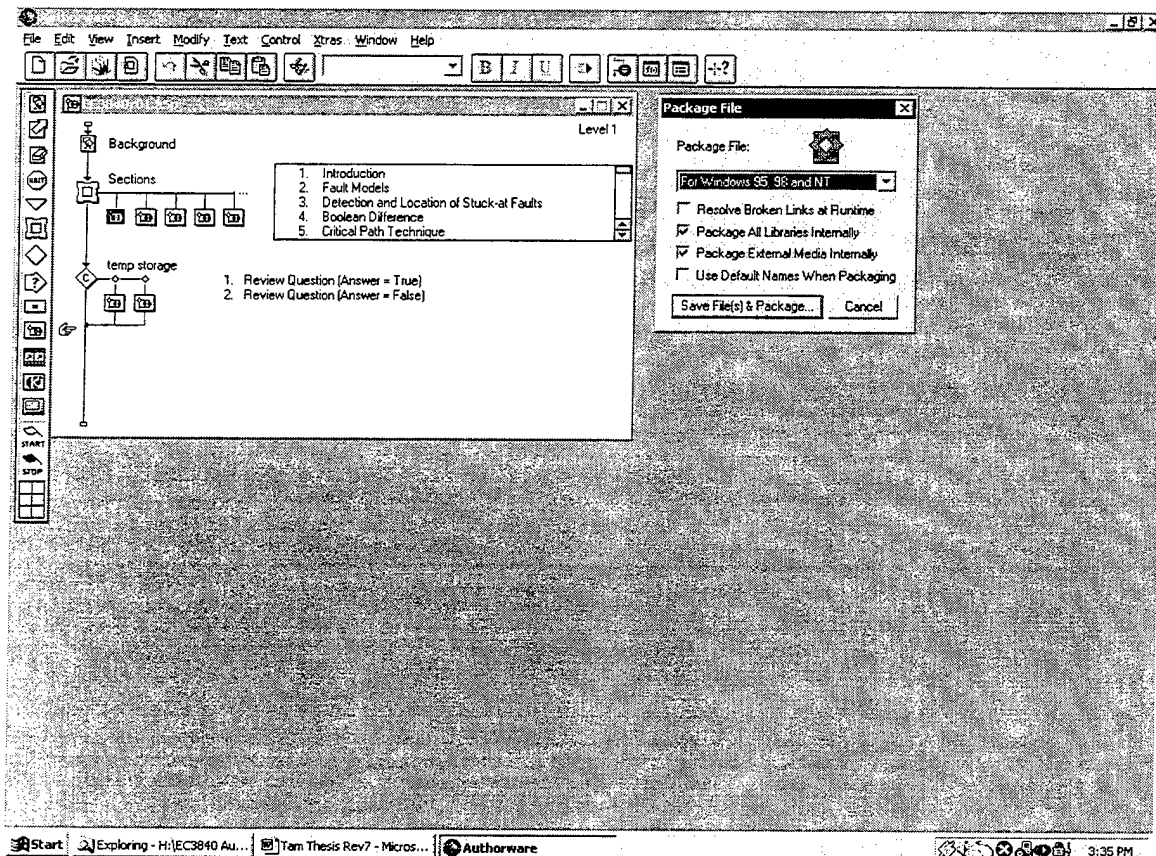


Figure A24. Package File menu

Step 25

Upon completion of Step 24, a new EC3840r01.exe file will be created in the H:/EC3840 Course - Executable/ directory. Double click on this new file and the program will be launched as shown in Figure A25.

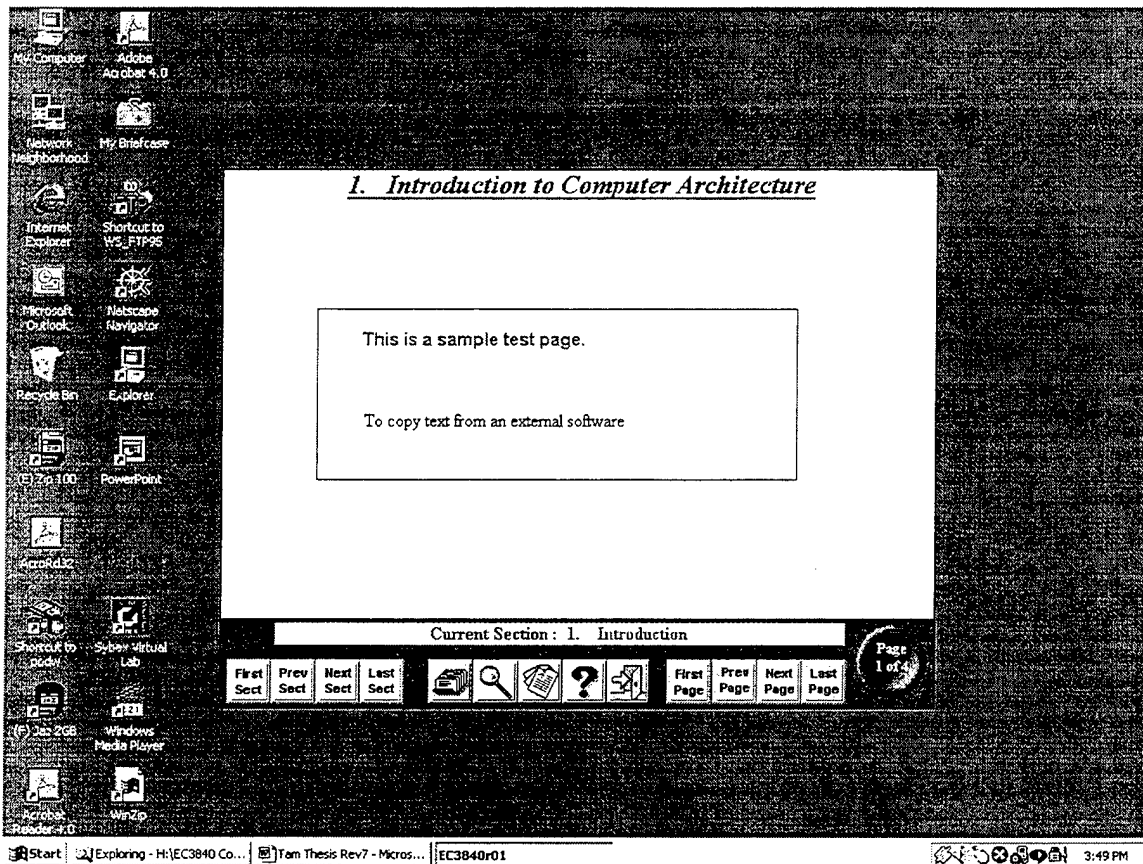


Figure A25. Launched executable file from hard disk

Step 26

To package the Authorware file for Internet application, first copy the directory H:/EC4810 Homepage & Online Course/ to a new directory and rename it (i.e. EC3840 Homepage & Online Course/) using Windows Explorer as shown in Figure A26. Next, select the f-4-courseware/online/ folder in this new EC3840 directory and erase all files except two winapi files.

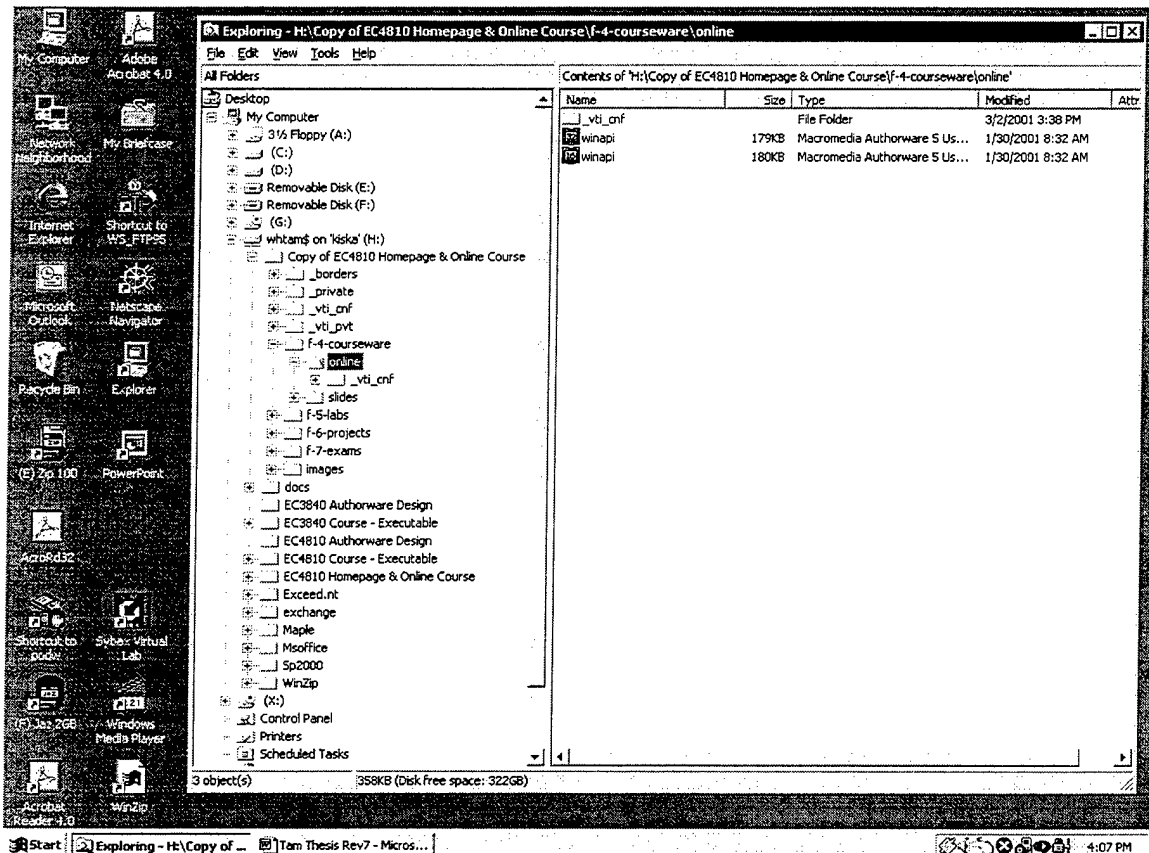


Figure A26. Create a new directory to package the Web-based file

Step 27

Launch the previously saved Authorware file from the H:/EC3840 Authorware Design/ directory again as in Step 24. Click on the **File | Package** and a new window will appear as shown in Figure A27. This time, select the “Without Runtime” option as well as the “Package All Libraries Internally” and “Package External Media Internally” options. Click **Save File(s) & Package** button to begin the packaging process. Another window will appear to request destination of packaged file, select the H:/EC3840 Homepage & Online Course/f-4-courseware/online/ directory previously created in Step 26.

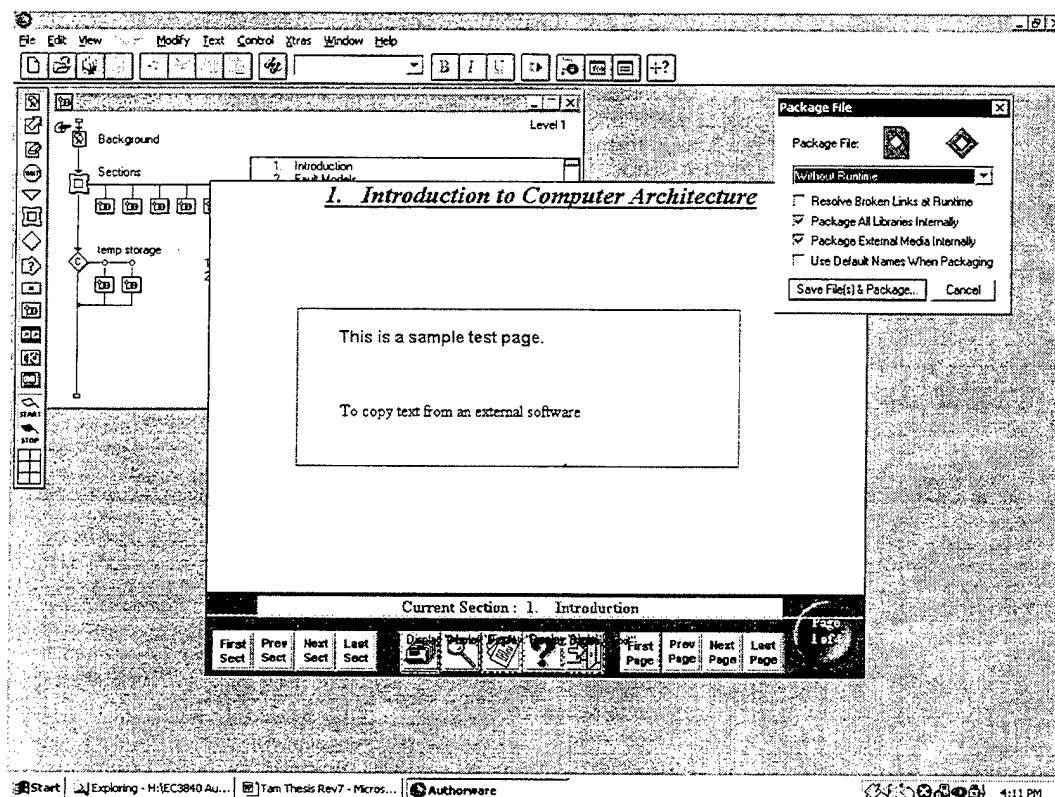


Figure A27. Package File menu

Step 28

Click on *Start | Programs | Macromedia Authorware 5 | Authorware Web Packager* to activate the Web Packager program as shown in Figure A28.

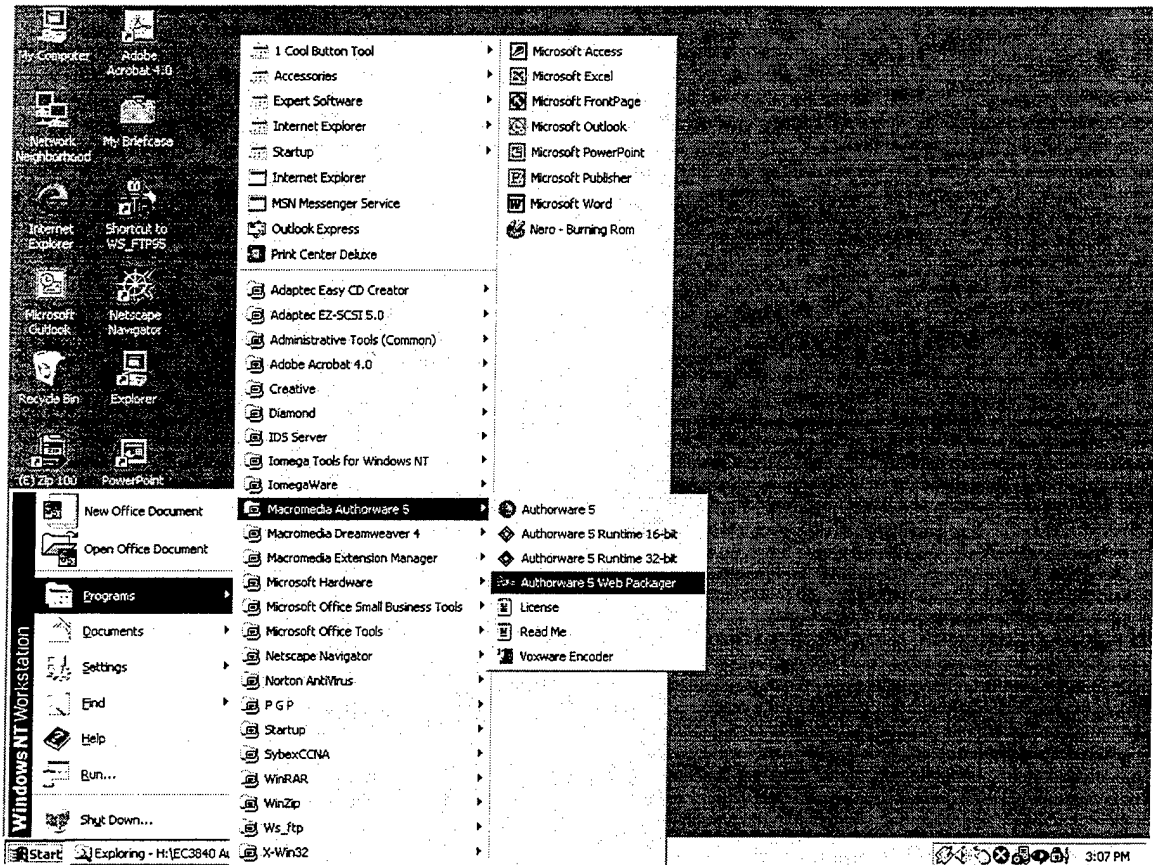


Figure A28. Activate the Authorware Web Packager program

Step 29

From the Authorware Web Packager, select and open the file EC3840r01.a5r previously generated from Step 28 (in the .../online folder). Subsequently, save the EC3840r01.aam file to the same directory as shown in Figure A29.

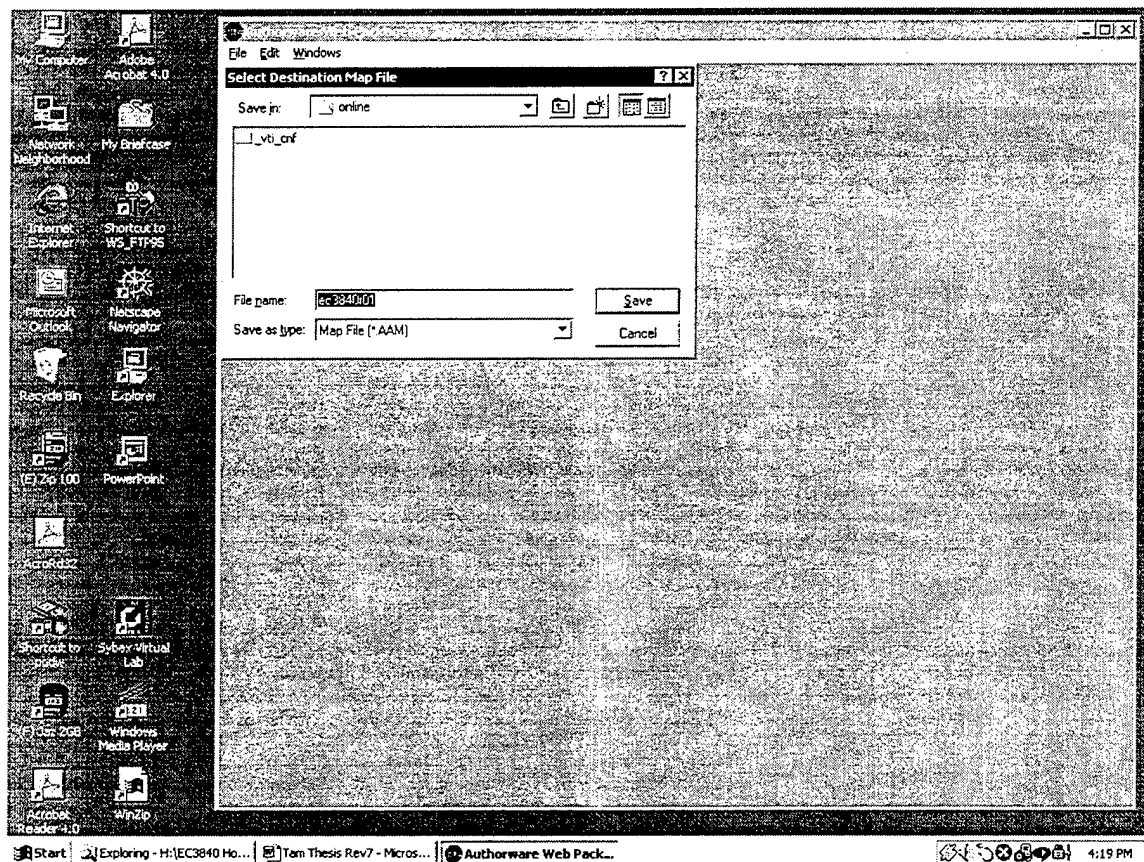


Figure A29. Save the Web-based Online Course in the .../online folder

Step 30

Another window appears as in Figure A30. This is the maximum segment setting for Authorware to package the online course to smaller segments used for streaming across the Internet. A segment size of 16Kbytes is recommended. Click on the OK to proceed. Once packaging is completed, close the Web Packager window. Appendix B details how to host the Web-based Authorware file (EC3840r01.aam or EC4810r23.aam) on the Internet Homepage.

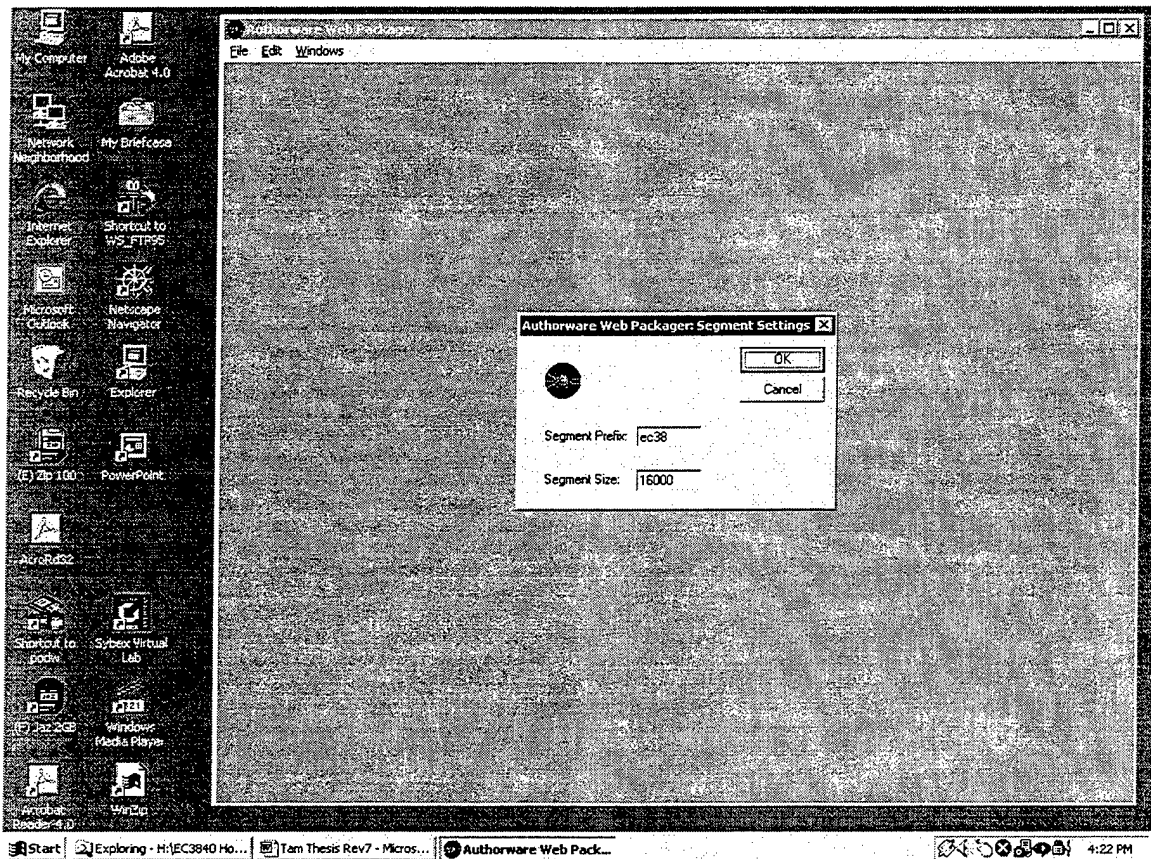


Figure A30. Segment size recommended for Web packaging

APPENDIX B. STEP-BY-STEP GUIDE FOR CREATING WEB PAGES

Step 1

Copy the directory H:/EC4810 Homepage & Online Course to a new directory and rename it (i.e. EC3840 Homepage & Online course) using Windows Explorer as shown in Figure B1. Ignore this step if already completed from Appendix A Step 26.

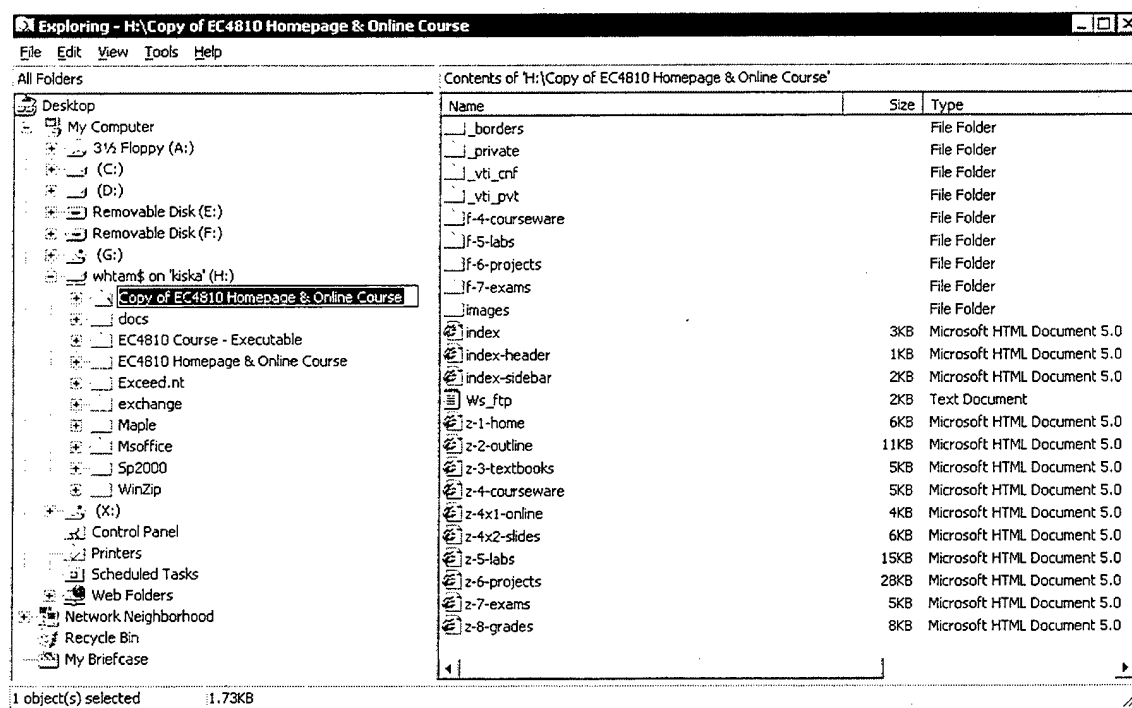


Figure B1. Copy entire template to another directory using Windows Explorer

Step 2

Launch the Windows FrontPage 2000 from the *Start | Programs | Microsoft FrontPage* menu. See Figure B2.

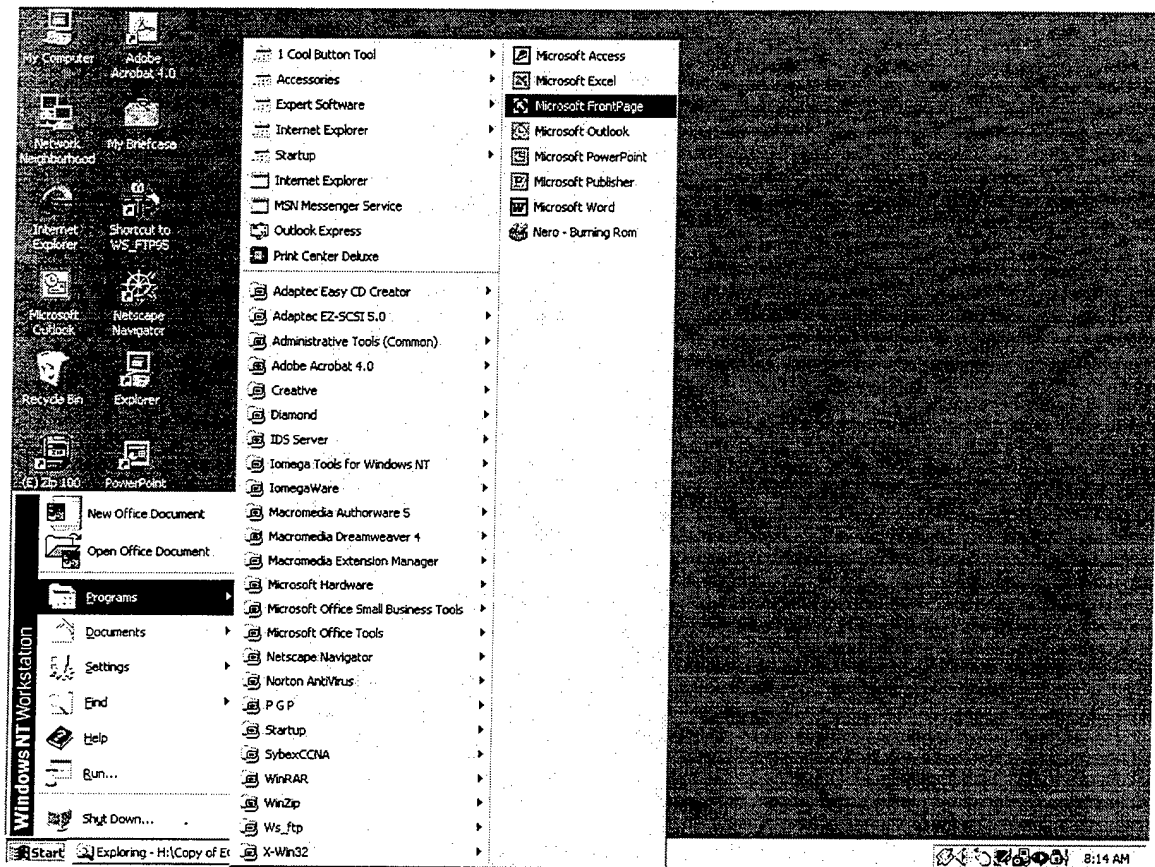


Figure B2. Launch the FrontPage 2000 application software from the Start menu

Step 3

In FrontPage, click on **File | Open** and double click on the new directory (i.e. EC3840 Homepage and Online Course). Select Index.htm (i.e. it should be highlighted) and click on the **Open** button as shown in Figure B3.

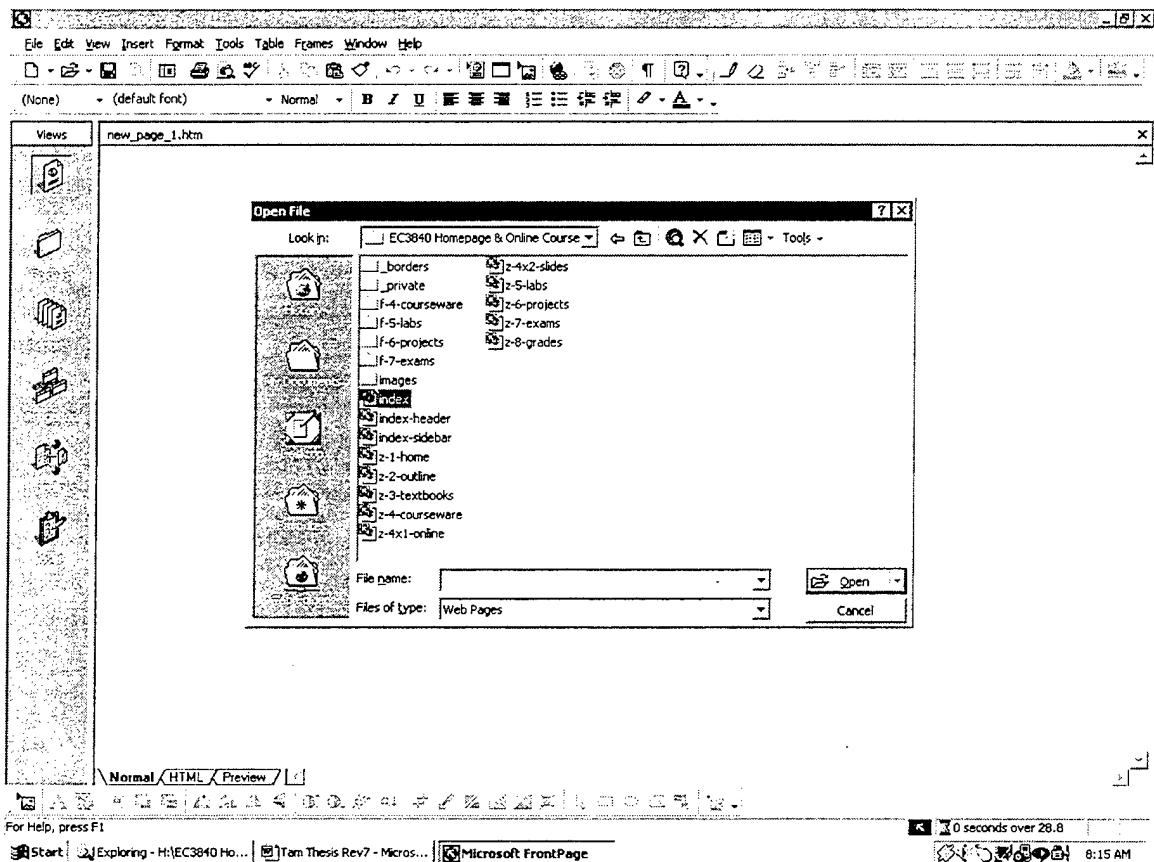


Figure B3. Open the new directory using FrontPage to work on

Step 4

Click on the *Navigation* button of the Views sidebar on the left of the display window, as shown in Figure B4.

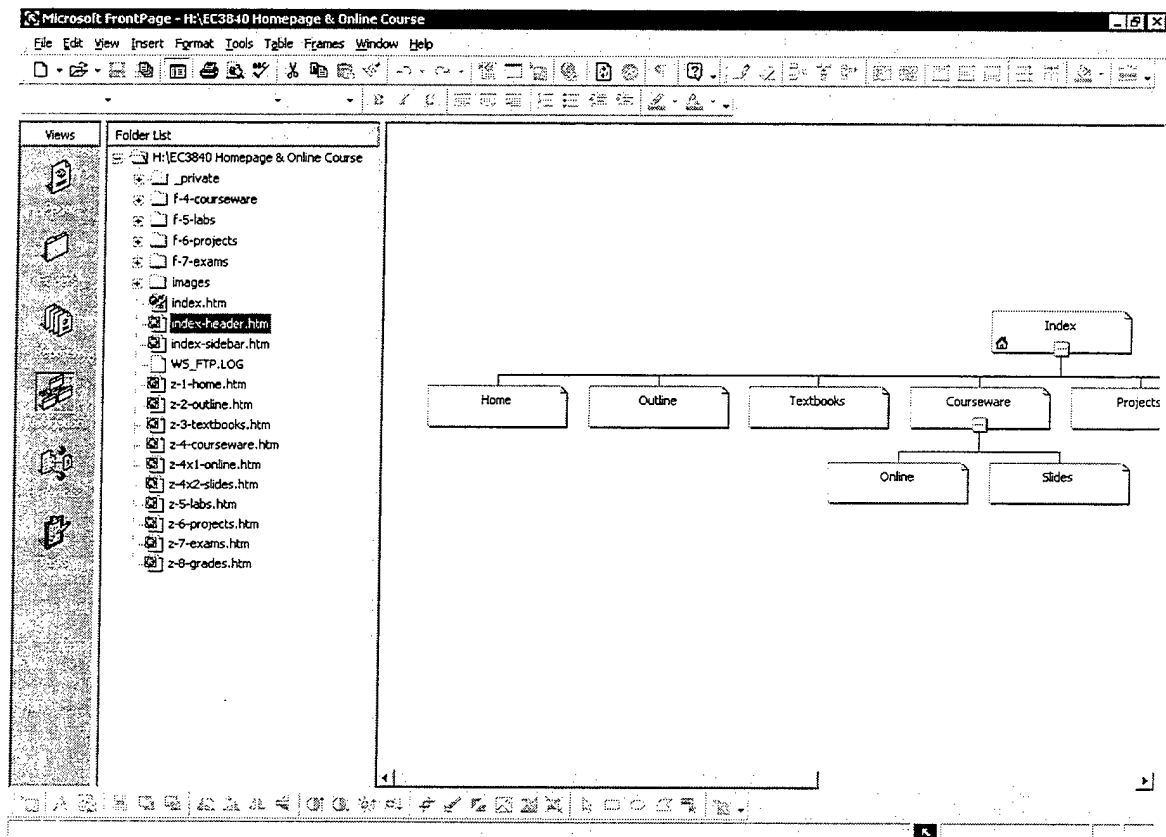


Figure B4. Navigation view of Web structure

Step 5

Click from the main menu View | **Toolbars** and select **Navigation** if the Navigation window was not already selected. A small Navigation window is displayed. Select the **Size to fit** option from the Navigation window as shown in Figure B5.

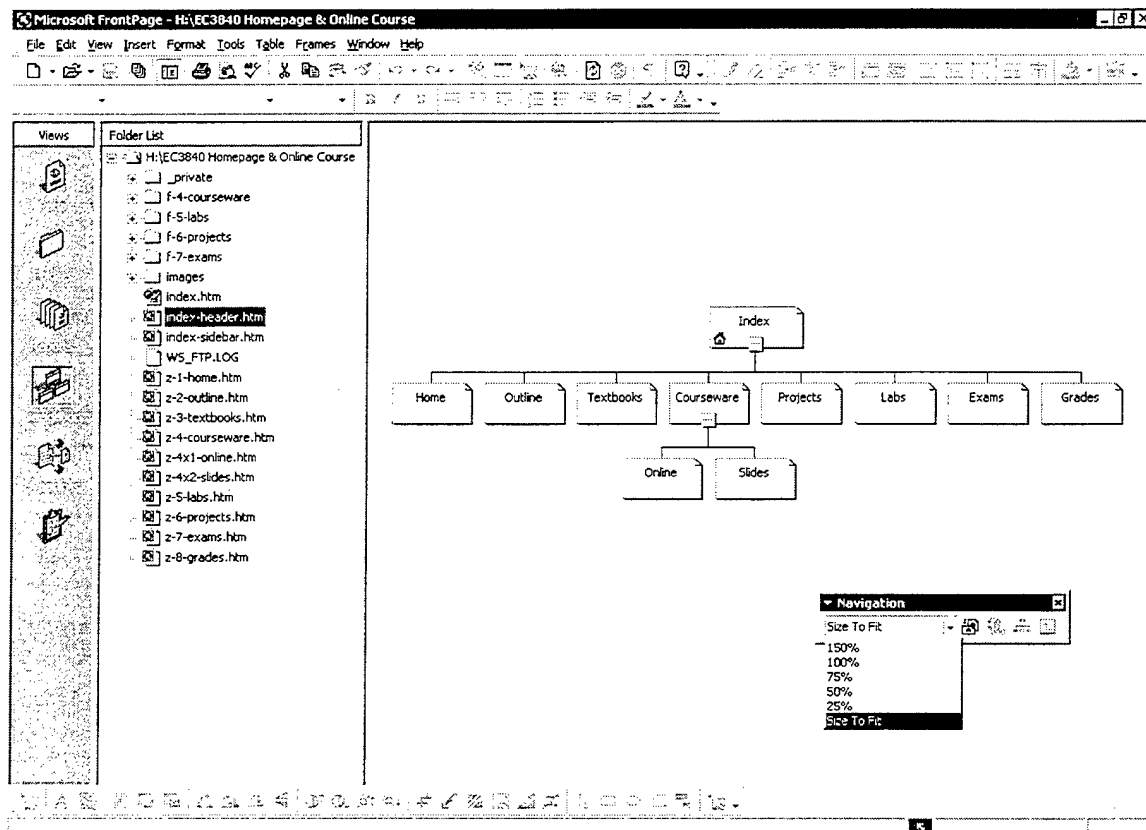


Figure B5. Fit to size the navigation view

Step 6

The FrontPage window should appear as in Figure B6. This provides an overall map view of the Web structure used and helps in the design of the navigation bar for the Web pages. The main (or parent) page is the Index.htm page with eight lower (or child) pages all on the same horizontal level. Each of these pages can have lower sub-level pages as required. The filenames of each of these files are shown in the Folder list (middle column of the window). To edit any of the pages, double click on the filename in the Folder list or in the main window.

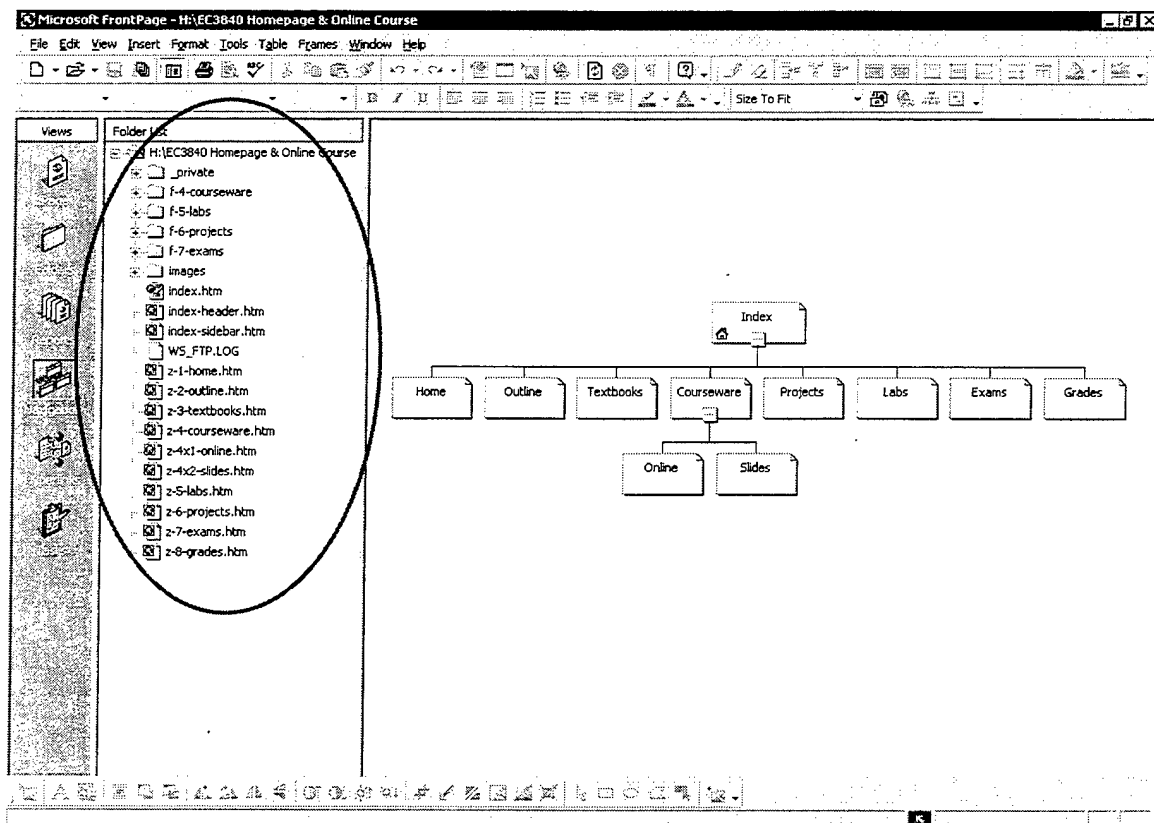


Figure B6. Folder list where all the Web page files are stored

Step 7

Double click on the Index.htm file from the Folder list to display its contents on the main window. The display should appear as in Figure B7. The Index.htm is the default main page used for most Web servers. This Index.htm consists of three frames; each is formed by another page, namely the Index-header, Index-sidebar, and the main frame window, which can be any of the eight lower horizontal level pages. The default page for the main frame window is set as the z-1-home.htm page.

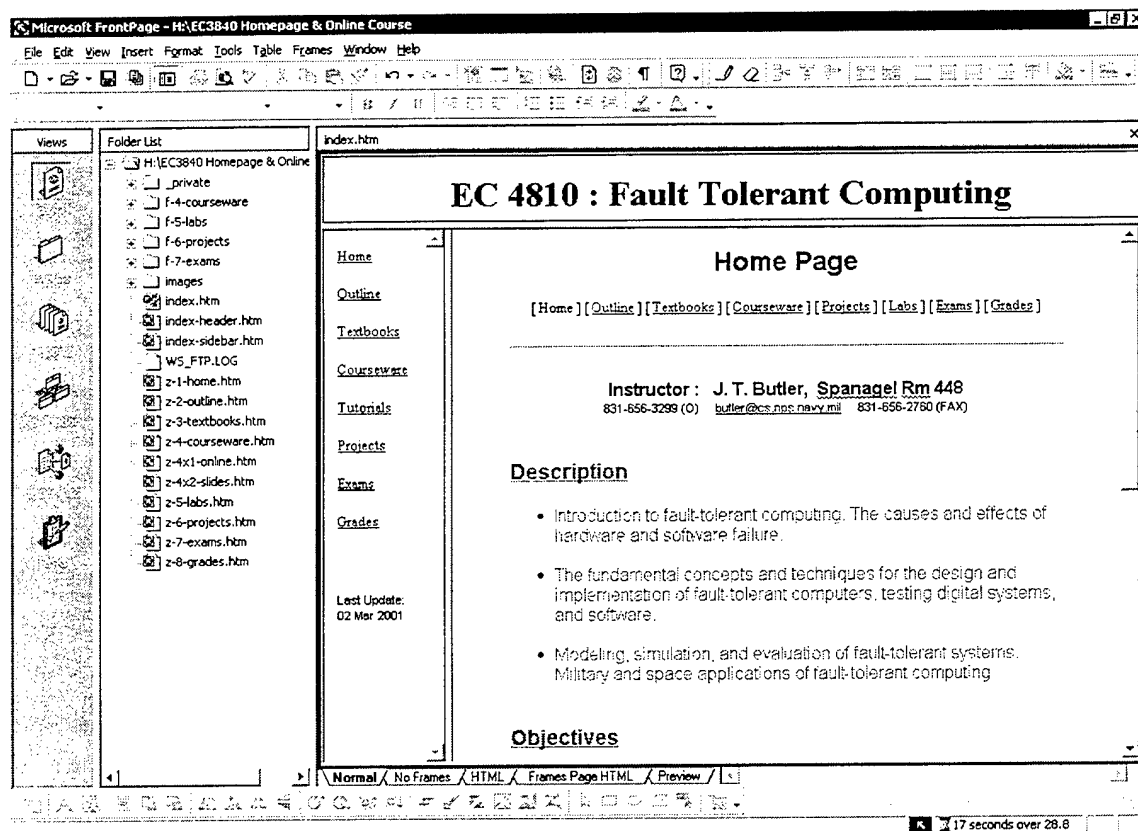


Figure B7. Page view selected from the left Views option window

Step 8

Double click on the Index-header.htm to change the title of the course as shown in Figure B8. Alternatively, you can remain in the main Index.htm page and edit the contents of the header page directly (note however that any changes made is saved to the Index-header.htm page). In the same way, the contents in the Index-sidebar can be edited directly from the Index.htm main page. A later step will describe how to add navigation bars for new pages to be created.

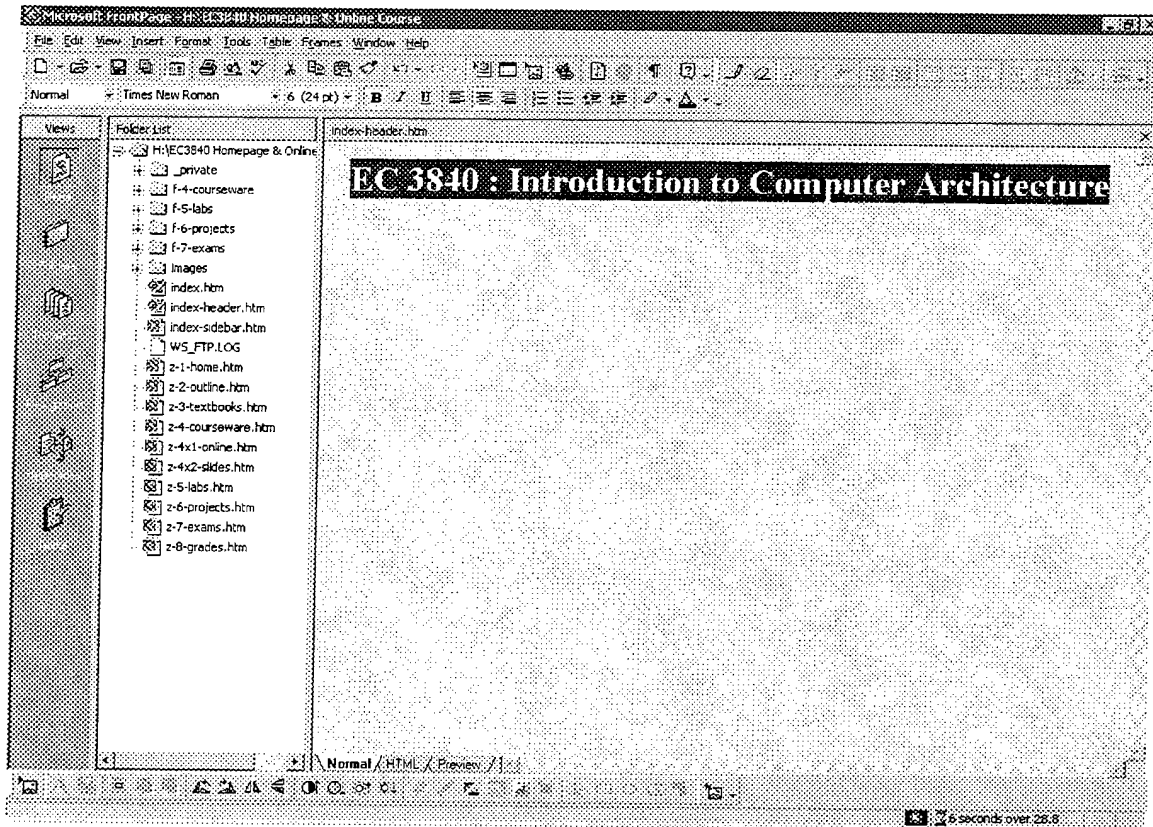


Figure B8. Edit the title on the header page

Step 9

Double click on the z-1-home.htm to make any changes for the homepage as shown in Figure B9. Note that this can also be edited directly from the Index.htm page, but the available display on the window will be smaller because of the header and sidebar pages.

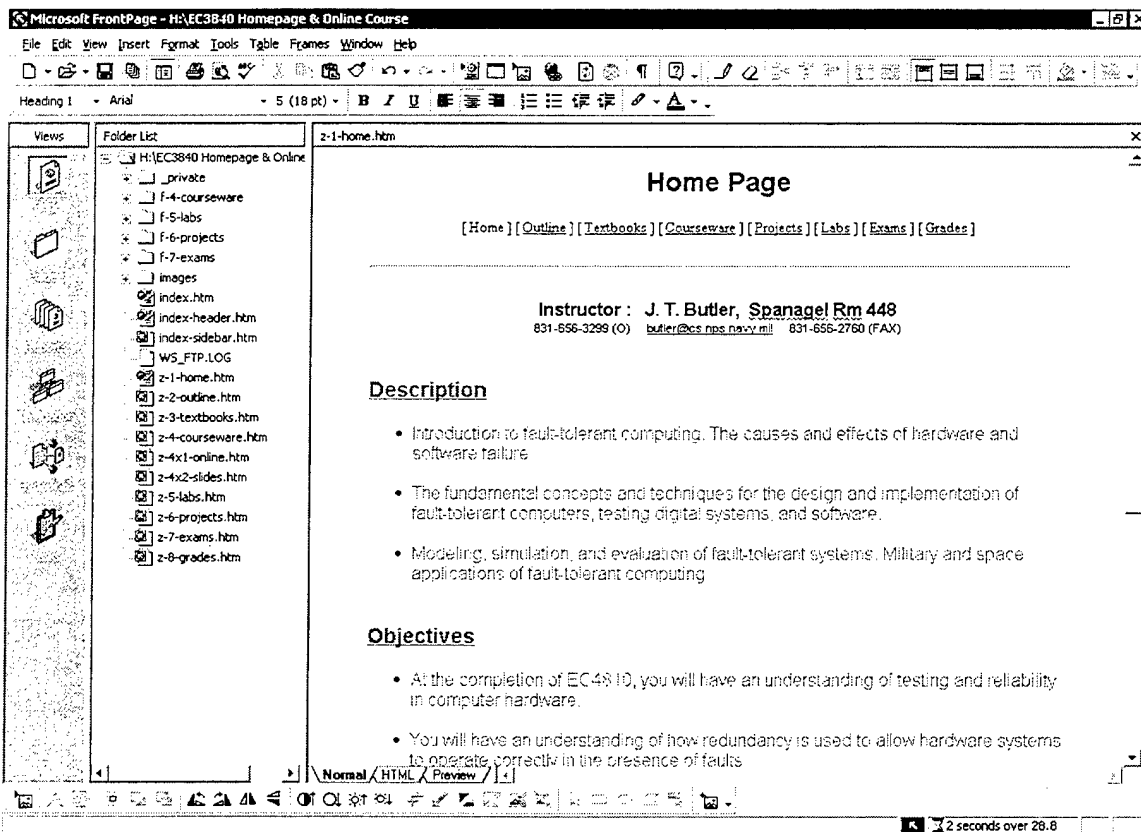


Figure B9. Edit the Home page using Page view

Step 10

The contents of the z-1-home.htm page can be edited just like any other Microsoft Office products. Font sizes, types, colors, etc. can be selected from the Formatting menu. The Show/Hide feature can be turn on or off as shown in Figure B10. Note that using the **Shift-Enter** keys (produces ¶ at the end of a line) instead of just the **Enter** key (produces ¶¶) reduces the amount of space between lines and helps group related material together with the same properties. To add an horizontal line across the page, place cursor at location and select **Insert | Horizontal line**.

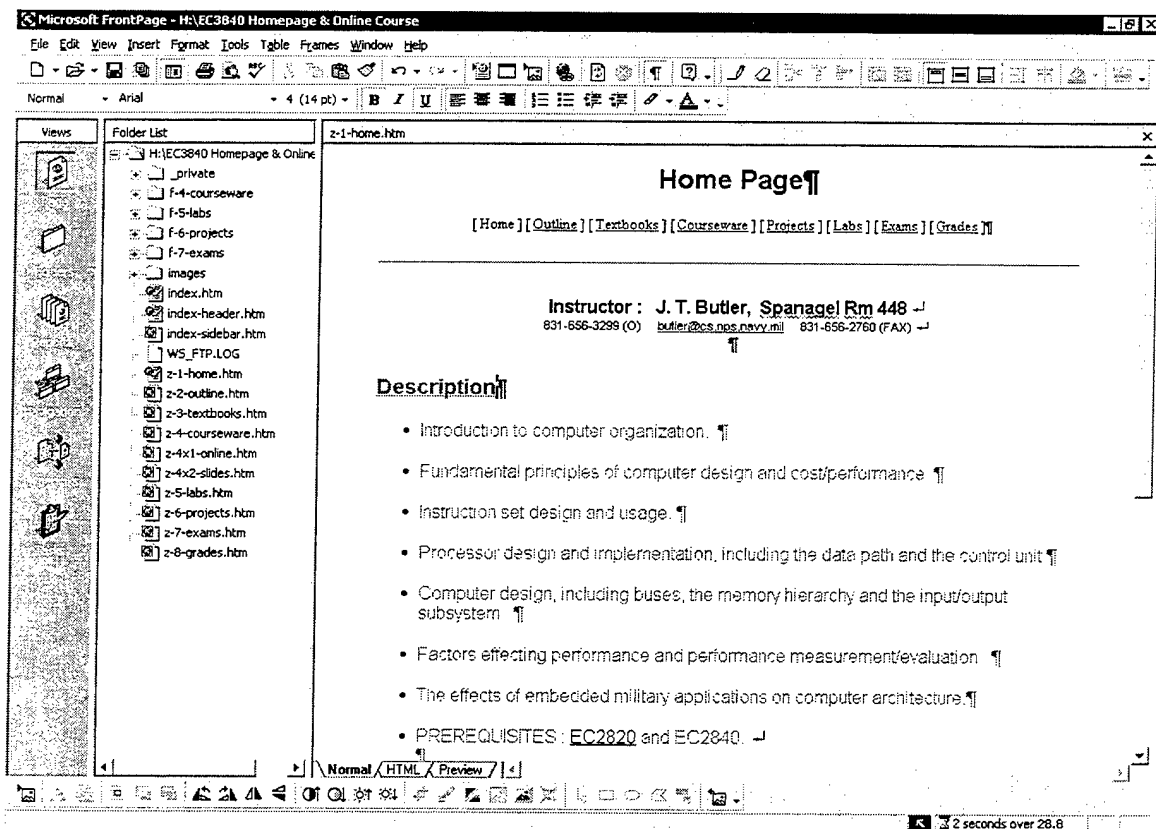


Figure B10. Page view with the Show/Hide ¶ feature turn on

Step 11

To add a hyperlink to any string of words or to any image, simply select it (highlighted) and type **Ctrl-K** (or **Alt-Enter** or Right click and select **Hyperlink Properties**). The Edit Hyperlink window will appear as shown in Figure B11. Select from the browse window the intended hyperlink file, or type the exact Web address on the URL entry. For email hyperlink, begin with "mailto:" follow by the email address.

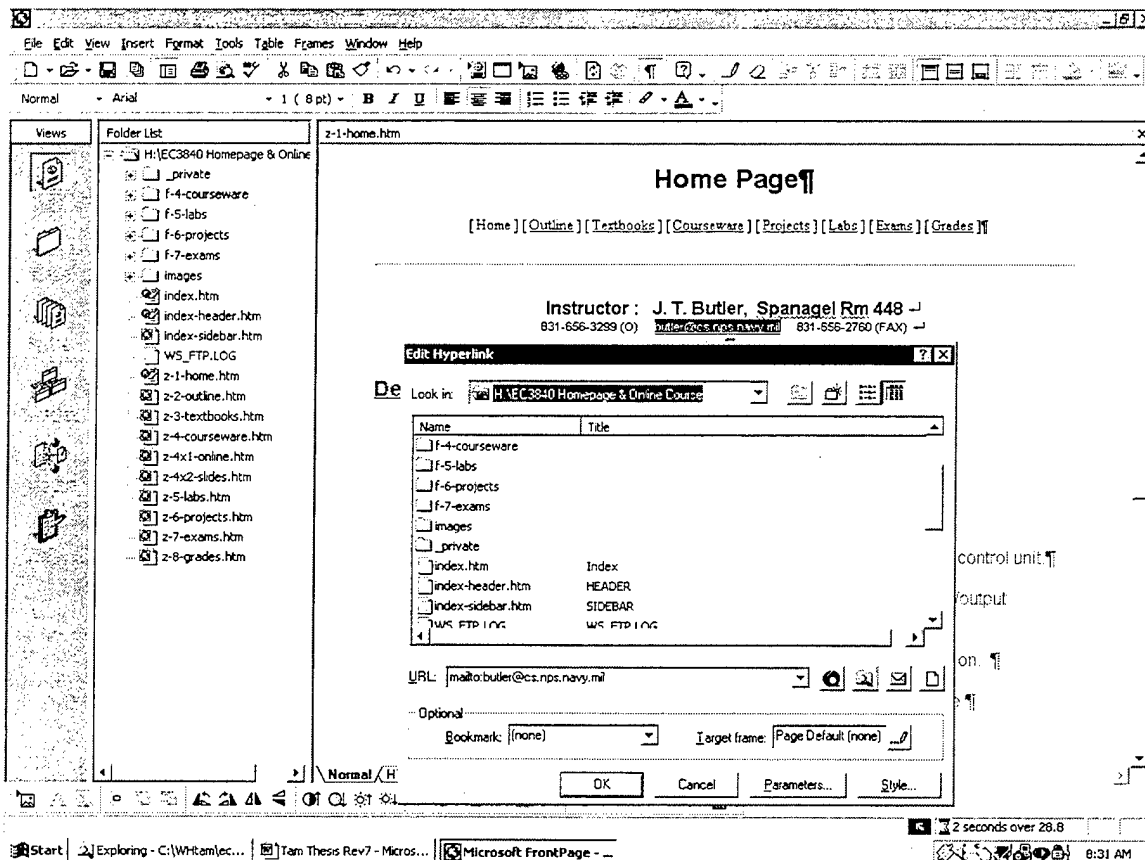


Figure B11. Edit Hyperlink menu

Step 12

To place the Navigation bars above each page, select it (highlighted) and click **Insert | Navigation** bar for the menu window to appear as in Figure B12. Select preferred settings and click OK.

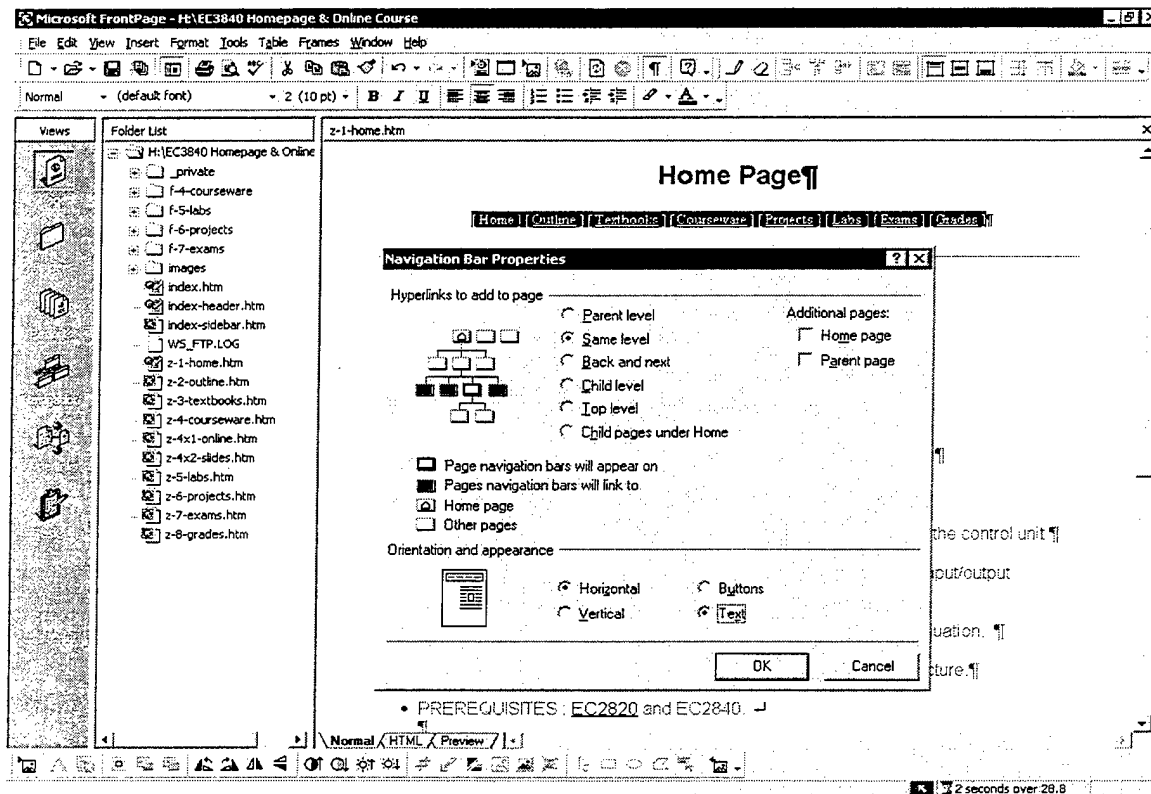


Figure B12. Edit the Navigation Bars Properties

Step 13

Scroll to the bottom of the page and click on the Footer area to edit the contents as appropriate. This is a shared border that will appear in every other horizontal level page. To change the shared border properties, click on **Format | Shared Borders** and the window as shown in Figure B13 will appear.

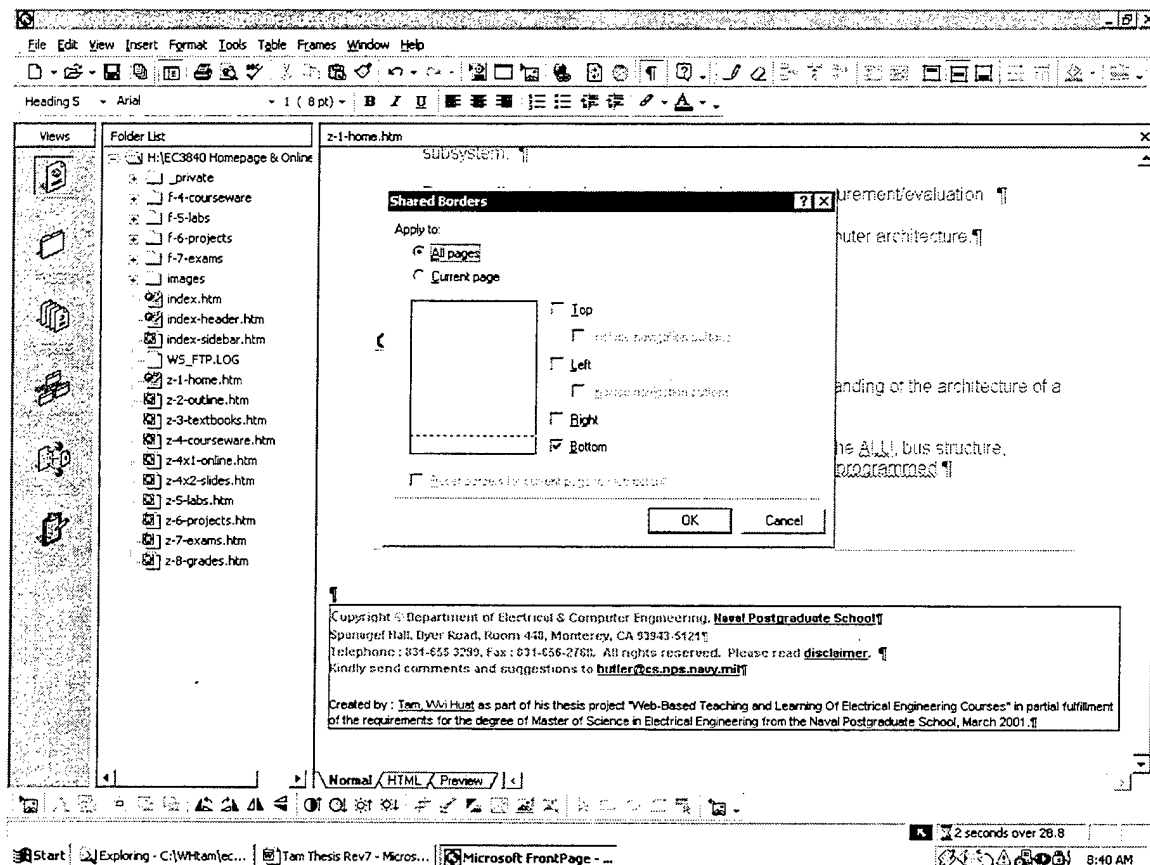
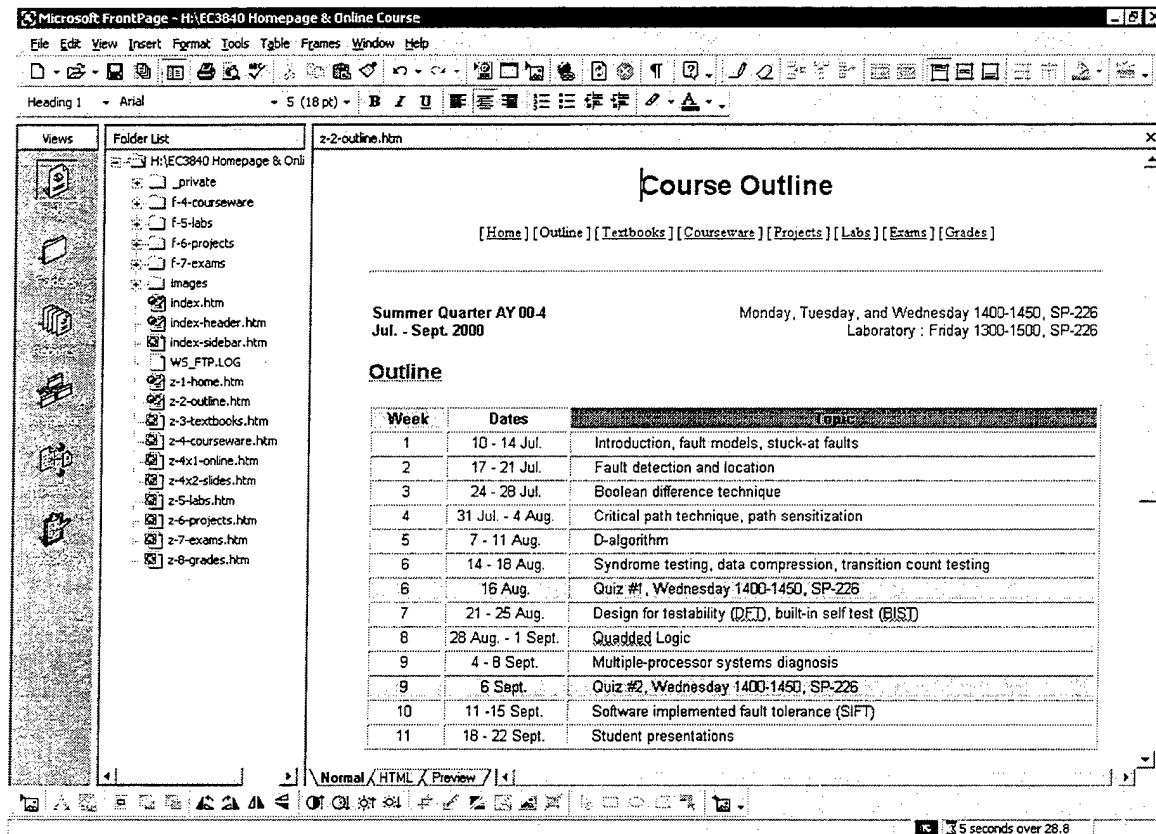


Figure B13. Shared Borders menu

Step 14

Double click on the z-2-outline.htm to make any changes for the course outline as shown in Figure B14. To insert or edit table, select from the Table menu as required, similar to other Microsoft Office software.



The screenshot shows the Microsoft FrontPage 2000 application window titled "Microsoft FrontPage - H:\EC3840 Homepage & Online Course". The menu bar includes File, Edit, View, Insert, Format, Tools, Table, Frames, Window, and Help. The toolbar contains various icons for editing and formatting. The folder list on the left shows the following files:

- private
- f-4-courseware
- f-5-labs
- f-6-projects
- f-7-exams
- images
- index.htm
- index-header.htm
- index-sidebar.htm
- WS_FTP.LOG
- z-1-home.htm
- z-2-outline.htm
- z-3-textbooks.htm
- z-4-courseware.htm
- z-4x1-online.htm
- z-4x2-slides.htm
- z-5-labs.htm
- z-6-projects.htm
- z-7-exams.htm
- z-8-grades.htm

The main content area displays the "z-2-outline.htm" file. The page title is "Course Outline". The navigation bar includes links: [Home] [Outline] [Textbooks] [Courseware] [Projects] [Labs] [Exams] [Grades]. The course information is as follows:

Summer Quarter AY 00-4
Jul. - Sept. 2000

Monday, Tuesday, and Wednesday 1400-1450, SP-226
Laboratory : Friday 1300-1500, SP-226

The "Outline" section contains a table with 11 weeks of topics:

Week	Dates	Topic
1	10 - 14 Jul.	Introduction, fault models, stuck-at faults
2	17 - 21 Jul.	Fault detection and location
3	24 - 28 Jul.	Boolean difference technique
4	31 Jul. - 4 Aug.	Critical path technique, path sensitization
5	7 - 11 Aug.	D-algorithm
6	14 - 18 Aug.	Syndrome testing, data compression, transition count testing
6	16 Aug.	Quiz #1, Wednesday 1400-1450, SP-226
7	21 - 25 Aug.	Design for testability (DFT), built-in self test (BIST)
8	28 Aug. - 1 Sept.	Quadded Logic
9	4 - 8 Sept.	Multiple-processor systems diagnosis
9	6 Sept.	Quiz #2, Wednesday 1400-1450, SP-226
10	11 -15 Sept.	Software implemented fault tolerance (SIFT)
11	18 - 22 Sept.	Student presentations

The status bar at the bottom indicates "5 seconds over 28.8".

Figure B14. Insert and edit tables

Step 15

To host the Authorware developed online course, all the Authorware compiled files need to be copied into the H:/EC3840 Homepage & Online Course/f-4-courseware/online/ directory using the Windows Explorer as shown in Figure B15.

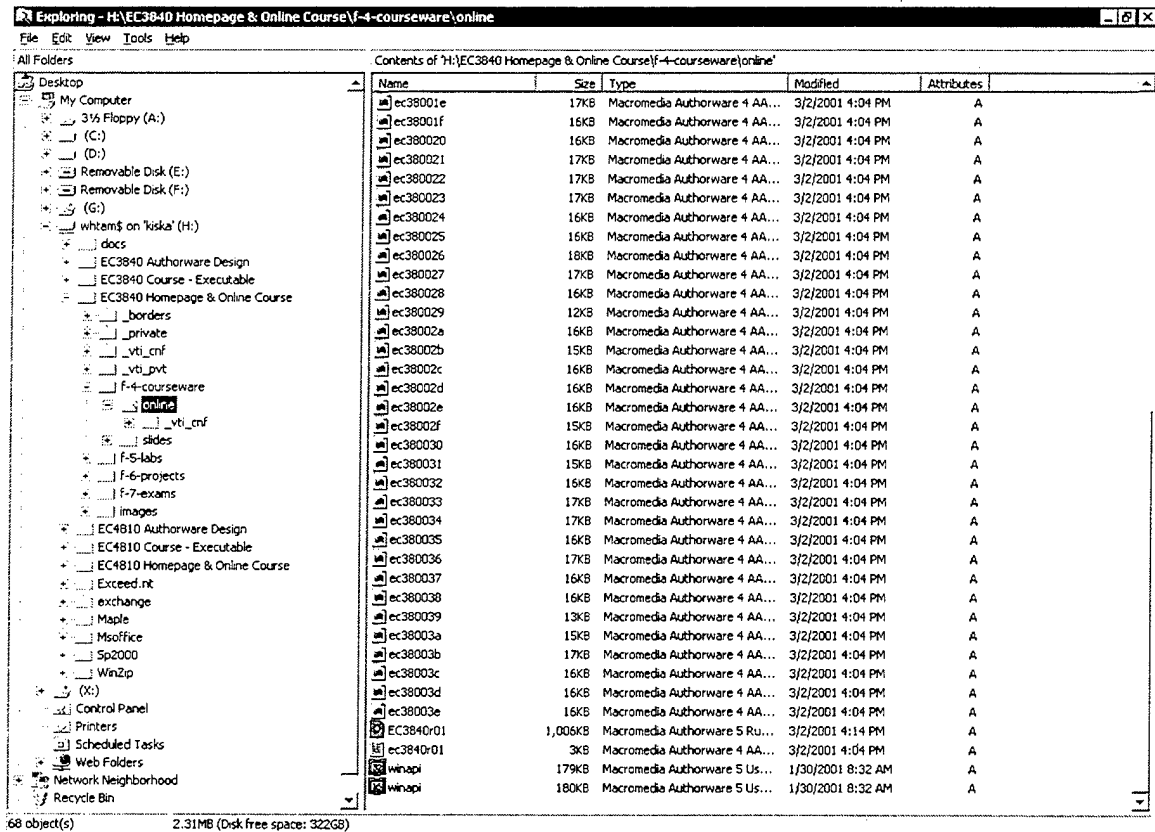


Figure B15. Copy Authorware developed online files to Web directory using Explorer

Step 16

Double click on the z-4x1-online.htm to make changes for inserting the Authorware developed online course. To change a directory or new Authorware file name, double click on the plug-in icon and a pop-up menu as shown in Figure B16 will appear. The Web-based Authorware online file EC4810r23.aam was created following steps from Appendix A. Make necessary changes to the directory name or filename (i.e. EC3840r01.aam) if another online course is designed.

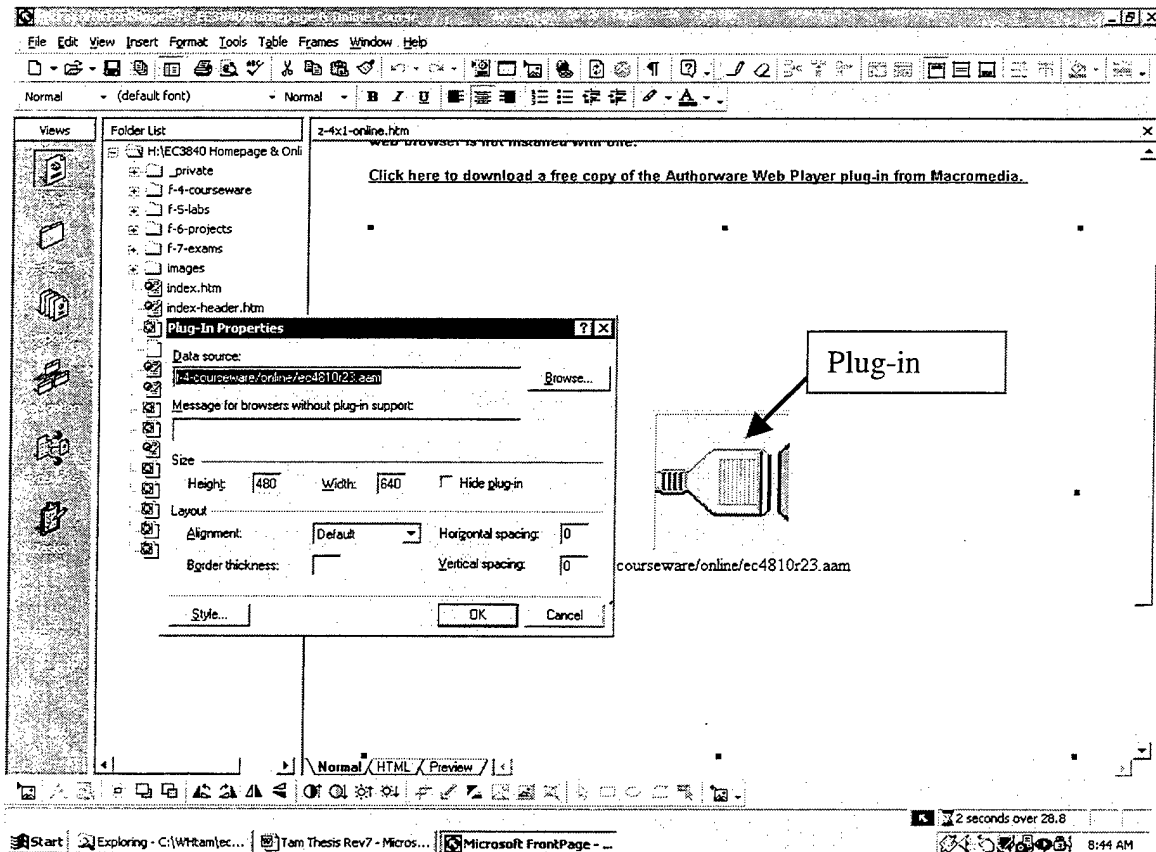


Figure B16. Edit the Plug-in Properties menu

Step 17

Double click on the z-4x2-slides.htm to make changes for inserting PowerPoint slides as appropriate. Highlight or select the title of each section and add hyperlink to corresponding files as appropriate (see Step 11 for adding of Hyperlink). See Figure B17. It is recommended that Word document (.doc) or PowerPoint slide (.ppt) files be converted to Adobe format before hosting on Web pages, because of its smaller size and faster download time.

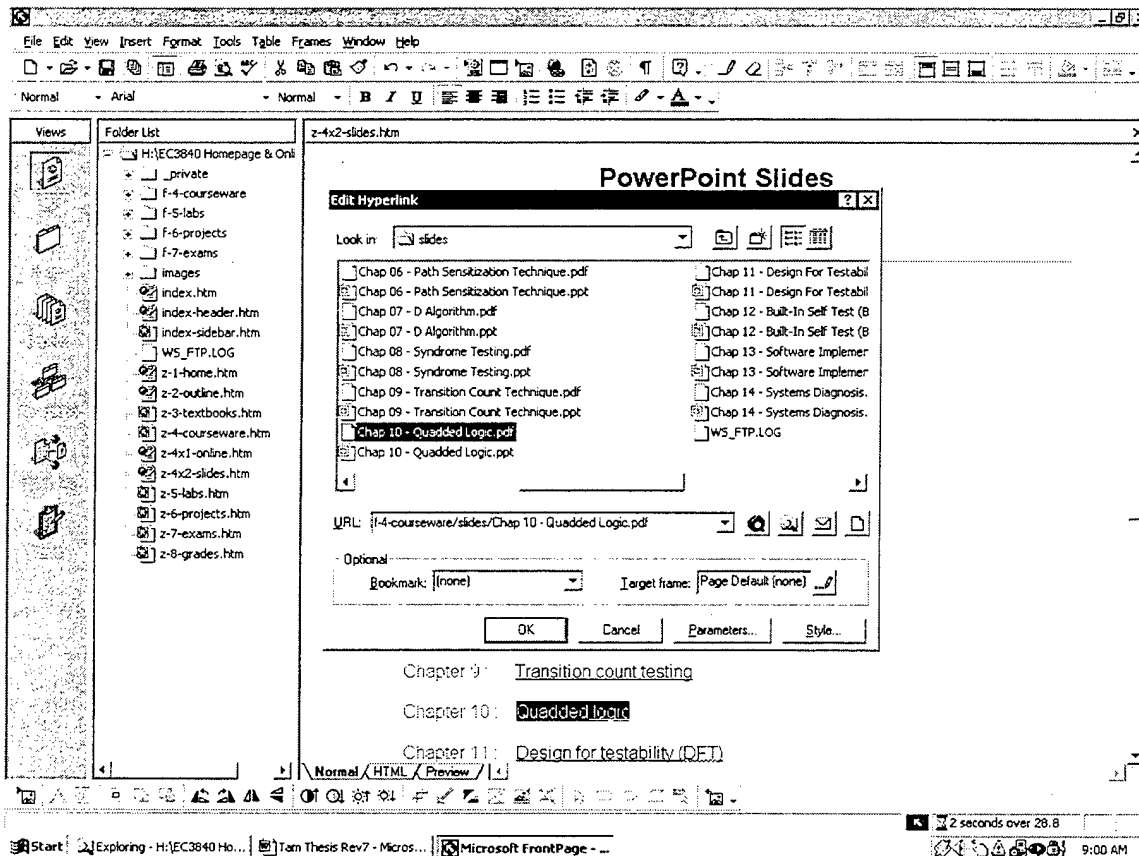


Figure B17. Add Hyperlink to Word, PowerPoint, or other files

Step 18

To add a new page, select **Normal Page** from the **File | New | Page** menu. Alternatively, copy a standard second level page and rename it (this is the recommended approach, since all the shared border and background properties will be inherited directly). To copy a file from the Folder list, right click once the z-1-home.htm (i.e. highlighted) and select **Copy**. Then right click again and select **Paste**; the z-1-home_copy(1).htm file appears. Right click once on the new file and rename it (i.e. z-9-video.htm). See Figure B18.

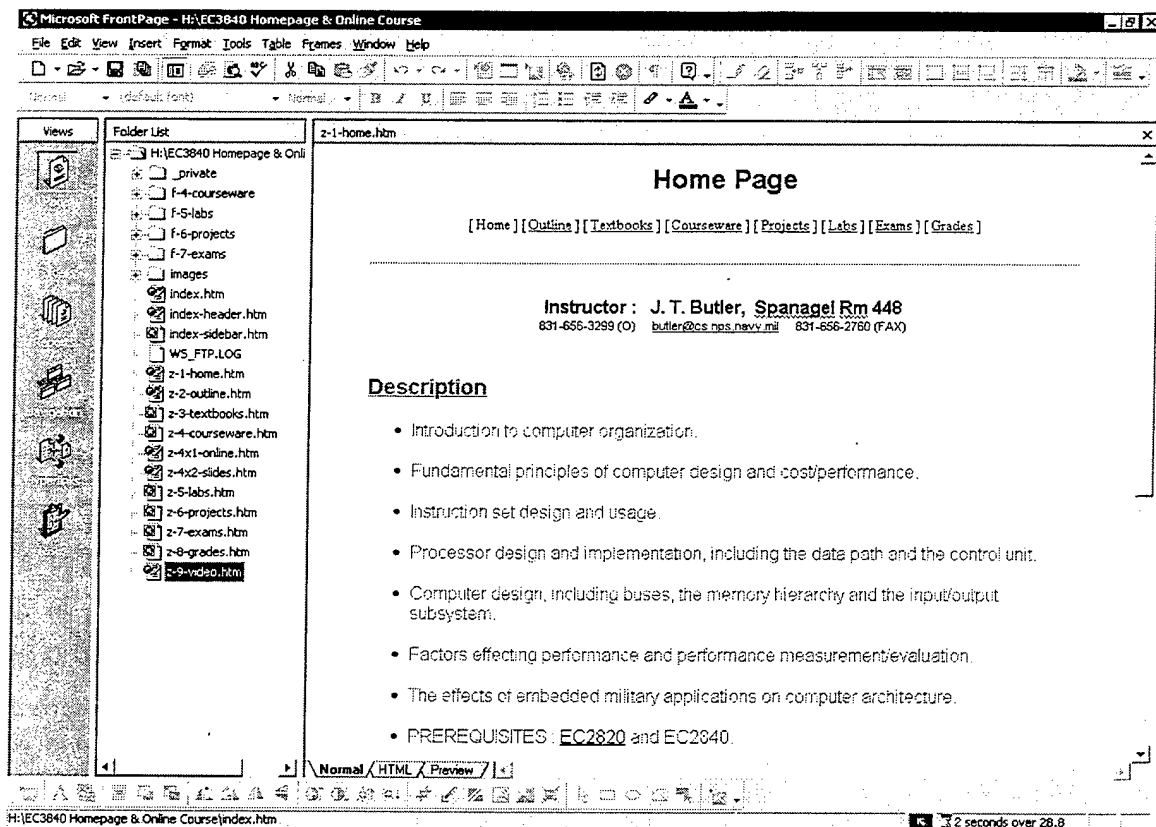


Figure B18. New file added in the Folder list

Step 19

Once a new page has been created, it needs to be added to the Web structure. Click the **Navigation** button of the Views sidebar on the left of the display window. Click on the new file name z-9-video.htm from the Folder list to highlight. Click, drag and drop file onto the main window on the right. A new page will appear under the tree structure with the name "Home Page". Click on it once or right click to select rename. Rename the file as appropriate (i.e. Video) as shown in Figure B19. Note that this is the name that will automatically appear in the navigation bars (as explained in the next step), and it is not the filename of this page.

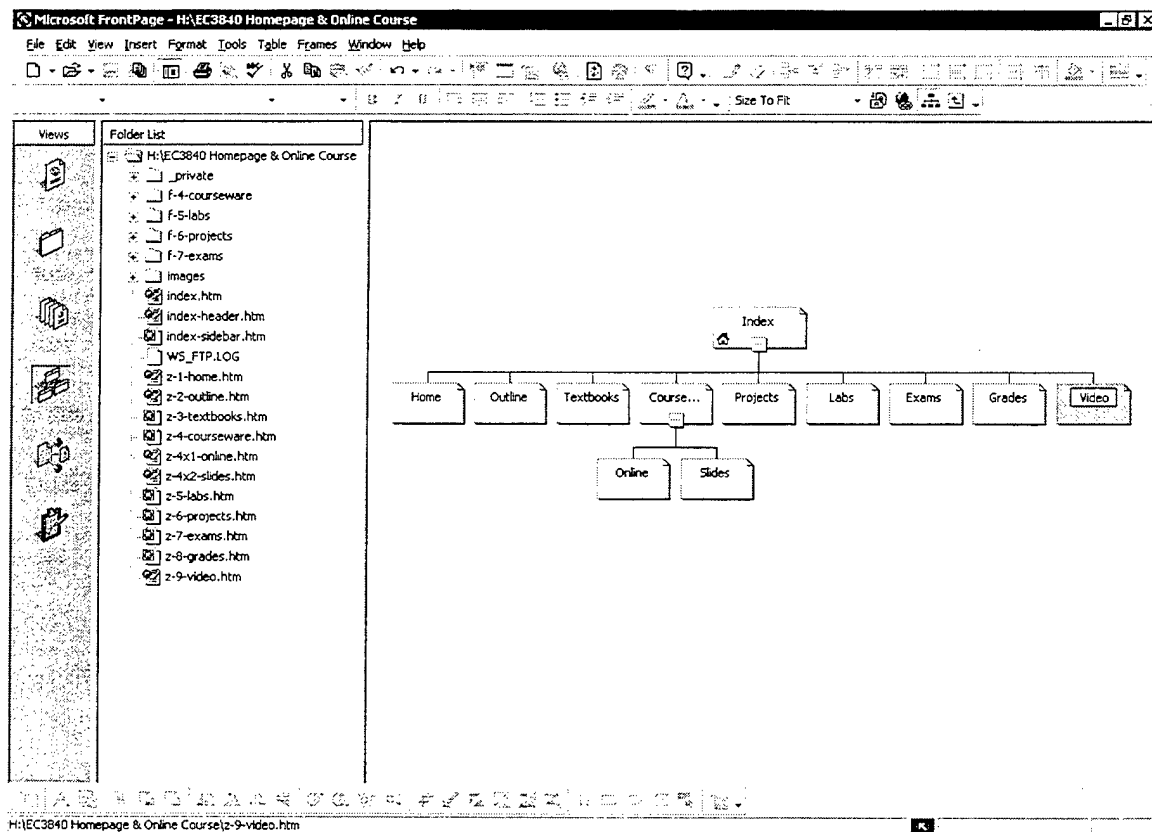


Figure B19. Drag and drop new file to Web structure and rename

Step 20

Double click on the new "Video" page to view and edit its contents. Note that at the top of the main window where the Navigation bars are, a link to the new Video page has been automatically added as shown in Figure B20. From the Folder list, click on any other pages and note that the Video page link has also been updated on all other horizontal level pages.

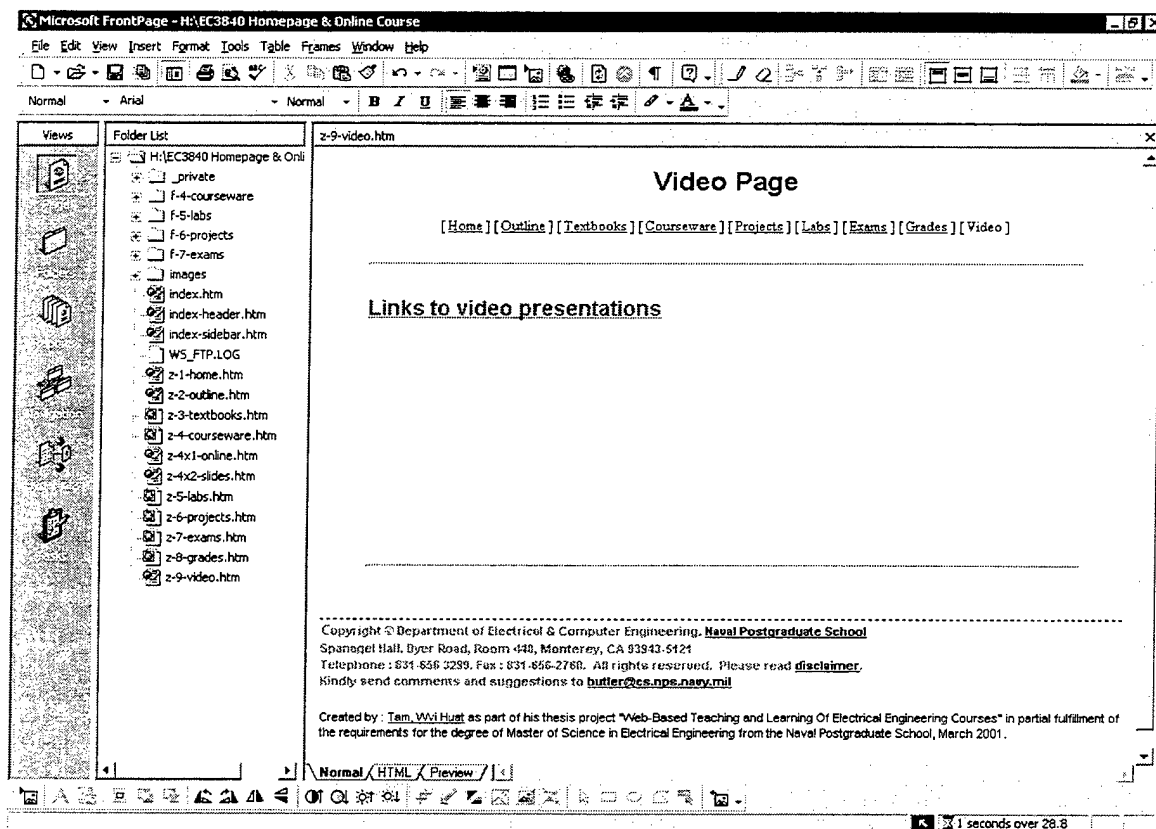


Figure B20. Page view of the new generated page

Step 21

Double click the file Index-sidebar.htm from the Folder list as shown in Figure B21. Add below the vertical list of navigation bars a word "Video". Double click on the word "Video" and add the hyperlink to the z-9-video.htm page. This completes the process of adding a new page to the Web site.

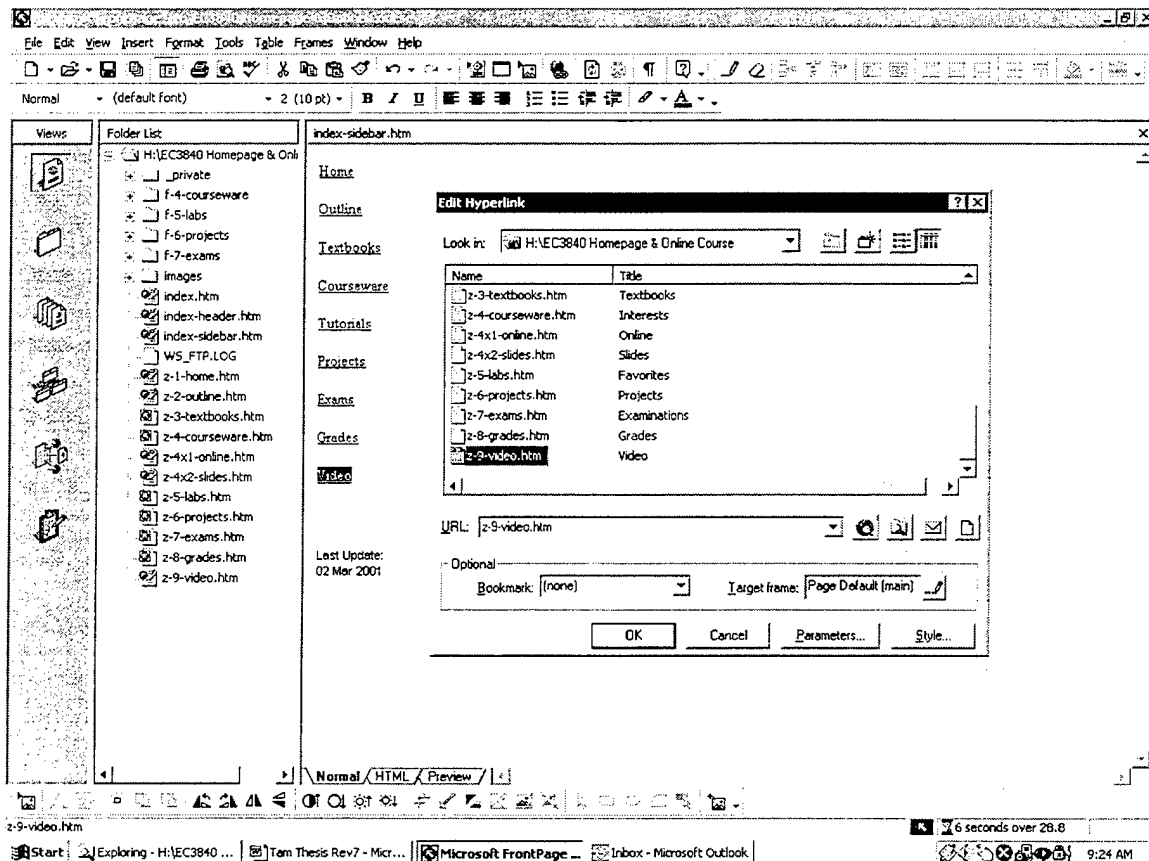


Figure B21. Update the Sidebar page with link to the new page

Step 22

To add a new document, first use Windows Explorer to move the file into the appropriate directory (i.e. H:/EC3840 Homepage & Online Course/f-5-labs/lab 6/). From the FrontPage Folder list, select the appropriate directory to find the corresponding file. Click, drag and drop the file onto the current page in the main right window, as shown in Figure B22. Rename the description of the file as appropriate. Alternatively, files can be added as hyperlink to a string of words by following Step 11.

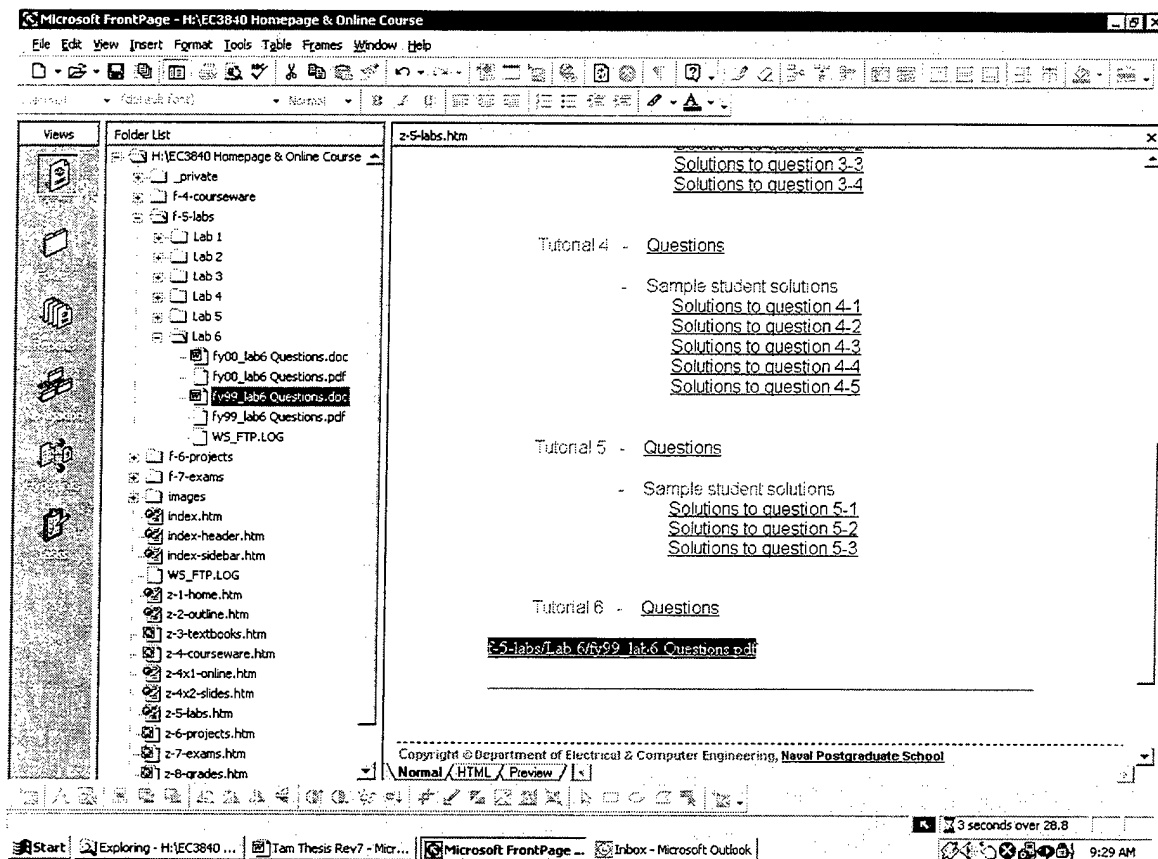


Figure B22. Drag and drop feature of FrontPage

Step 23

To add or change a new background, first use Windows Explorer to copy the new background image file into the H:/EC3840 Homepage & Online Course/images/ directory. Then select the appropriate file with background to be changed from the Page view. Click on Format | Background and the Page Properties menu will appear as shown in Figure B23. Make necessary changes as appropriate.

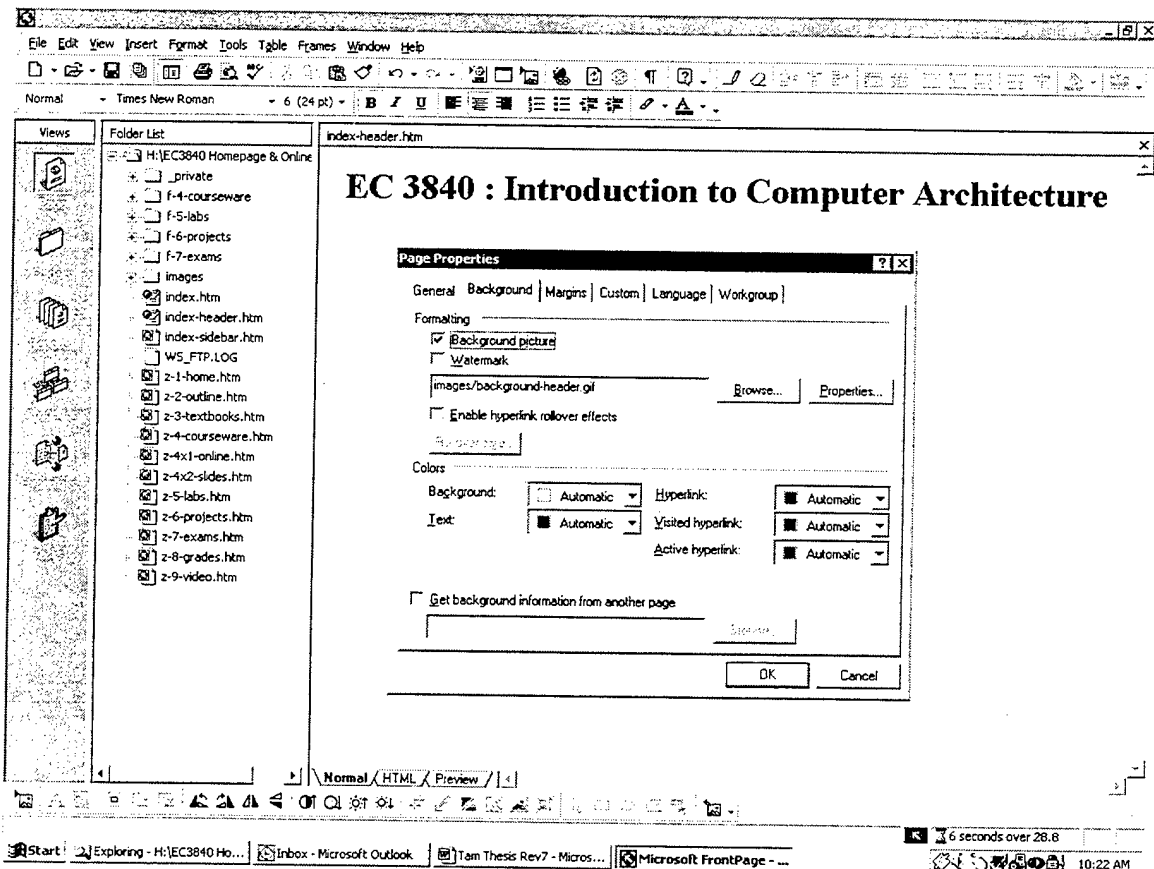


Figure B23. Page Properties menu

Step 24

To see the effects of Web design at any time, save all changes using **Ctrl-S** or click **File | Save**. Click on the **Index.htm** file once to highlight it. Then select the **File | Preview in Browser** for a pop-up menu. Select the **Automatically save page** option and click on the **Preview** button as shown in Figure B24.

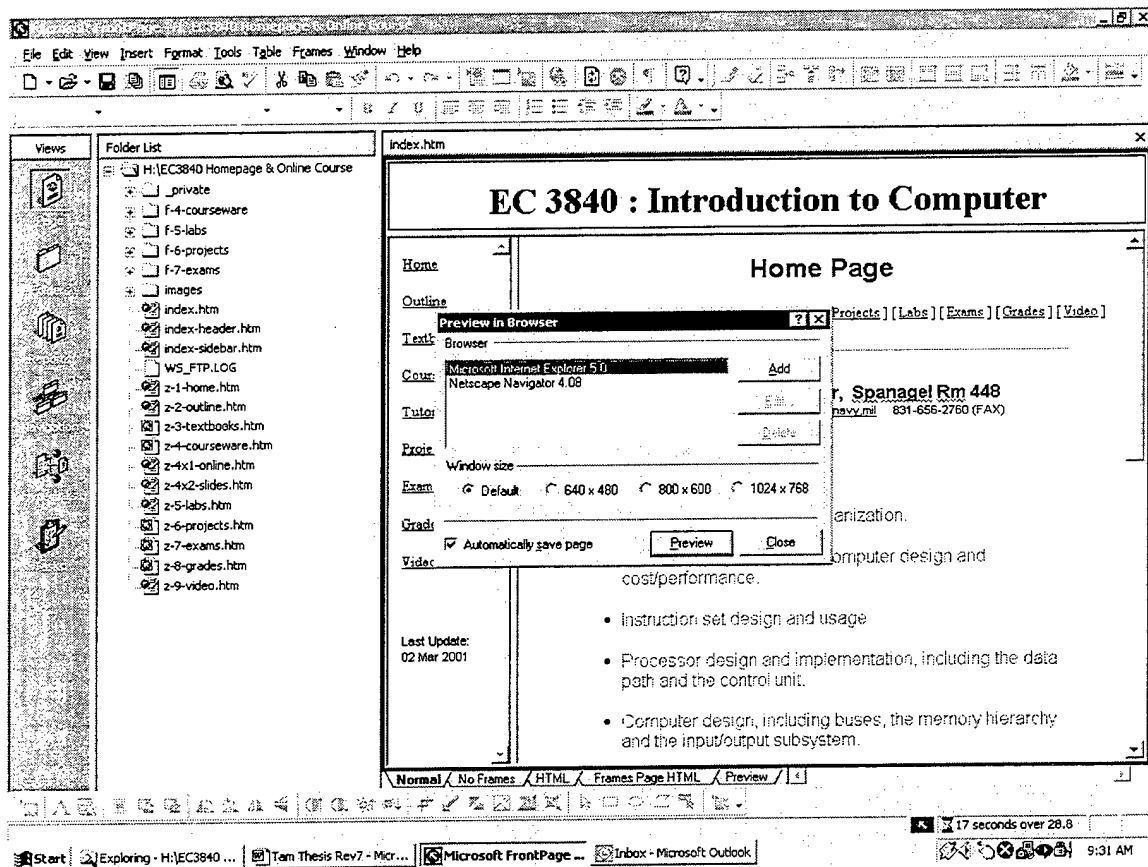


Figure B24. Preview in Browser menu

Step 25

Once satisfied with the Web design, exit from FrontPage by selecting File | Exit. Remember to save all changes to Web pages before exiting. When closing the application, FrontPage will prompt you if you have made recent changes to a page and have not saved it yet. See Figure B25.

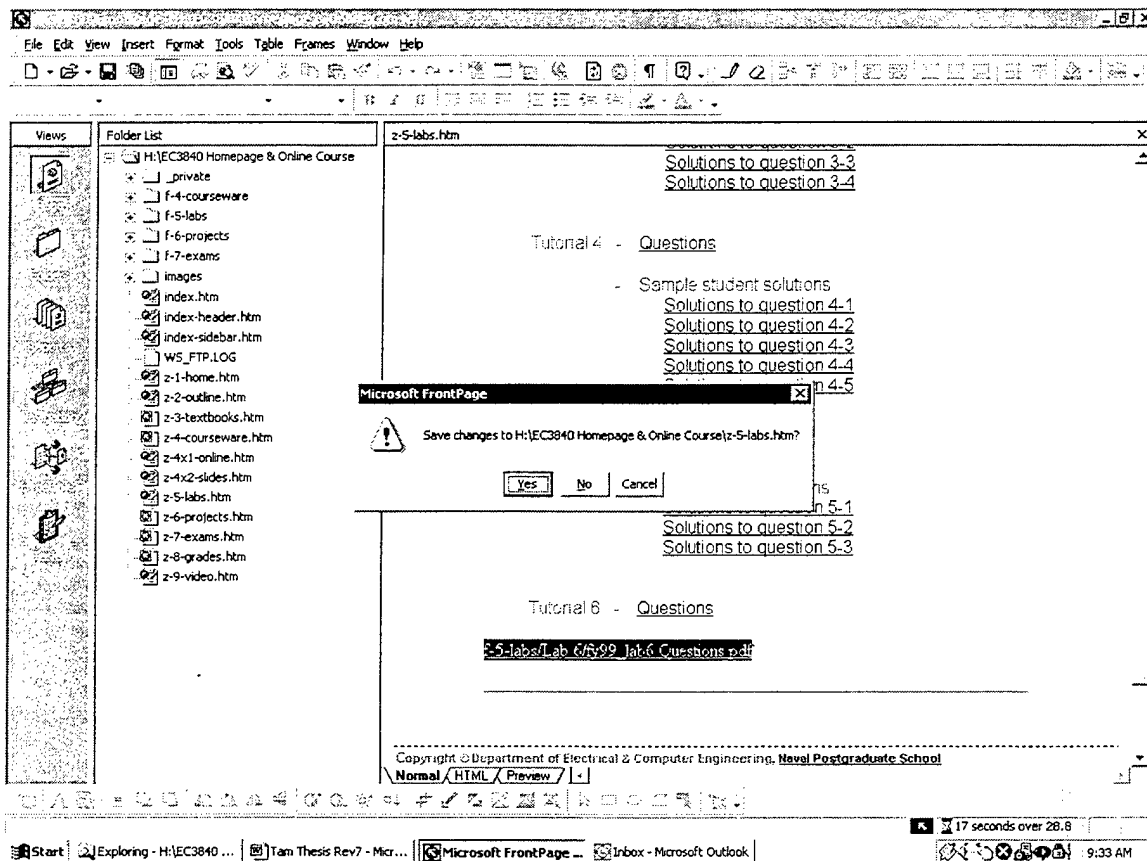


Figure B25. Save all changes before exiting FrontPage

Step 26

Any FTP software can be used to download the designed Web pages into the appropriate Web server. The WS_FTP software is recommended as shown in Figure B26.

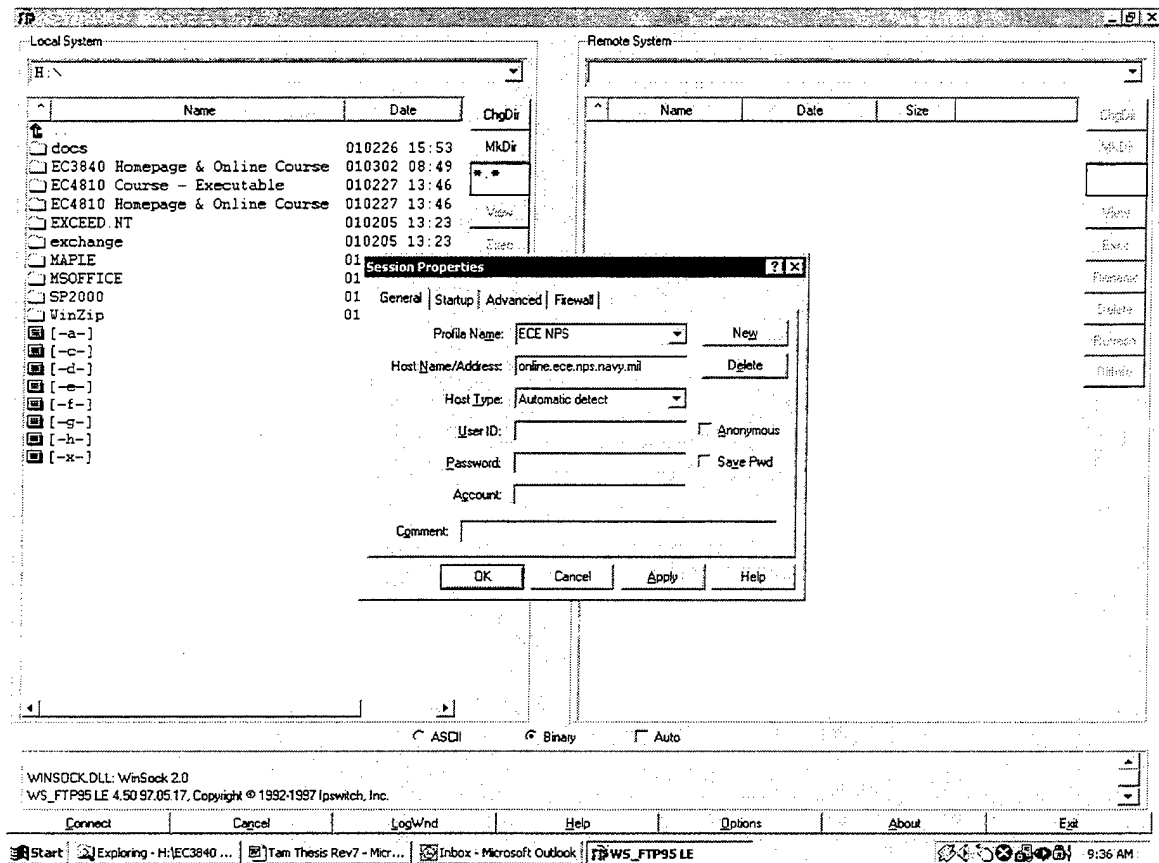


Figure B26. Use FTP software to transfer all Web files to the Web server

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